GEOGRAPHICAL HARVEST PATTERNS OF COHO SALMON IN THE UPPER SUBDISTRICT SET GILL NET FISHERY, UPPER COOK INLET ALASKA, 1990.

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Regional Information Report[1] No. 2S91-7

Alaska Department of Fish and Game
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333 Raspberry Road
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[1] Contribution 91-7 is from the Soldotna Area office. The Regional Information Report Series was established in 1987 to provide an information access system for all unpublished divisional reports. These reports frequently serve diverse ad hoc informational purposes or archive basic uninterpreted data. To accommodate timely reporting of recently collected information, reports in this series undergo only limited internal review and may contain preliminary data; this information may be subsequently finalized and published in the formal literature.

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AUTHORS

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INTRODUCTION

The State of Alaska, Board of Fisheries, has provided the Alaska Department of Fish and Game (ADF&G) with long-term direction for management of Upper Cook Inlet (UCI, Figure 1) salmon stocks with their adoption into regulation of the Upper Cook Inlet Salmon Management Plan (5AAC 21.363, ADF&G 1990). The Plan directs: "from July 1 through August 15, salmon stocks which normally move in Upper Cook Inlet will be managed primarily for commercial uses:". The Plan further states that ADF&G shall " manage the Upper Cook Inlet commercial salmon fisheries to minimize the incidental take of Susitna coho, late Kenai king, and early Kenai coho salmon stocks." While ADF&G has annually reviewed management approaches with the Board of Fisheries relative to these directives, some recreational users have maintained additional techniques still need to be developed to reduce the commercial harvest of Kenai River coho (*Oncorhynchus kisutch*) and chinook (*O. tshawytscha*) salmon.

In 1990 ADF&G initiated a study of the Upper Subdistrict salmon set gill net fishery to define areas that would allow harvest of Kenai and Kasilof River sockeye salmon while minimizing the incidental take of early run Kenai River coho stocks. Tarbox et al. (1987) reported the results of a similar investigation on chinook salmon harvest patterns. A secondary objective of the study was to better understand the dynamics of Upper Subdistrict set gill net fishery. This fishery has been expanding (Figure 2), concurrent with increased salmon returns to the Kasilof and Kenai Rivers yet data are lacking on the distribution of fishing effort, gear type used, and movement of gear between areas.

METHODS

Beginning in early July a voluntary questionnaire (Appendix A.1) was distributed to Upper Subdistrict set gill net commercial fishermen. Information requested included name, permit number, specific location of nets, mesh size, net depth, distance fished from shore and the names and permit numbers of persons that fished together. Since UCI permit holders often deliver a combined catch on one permit, use of individual permit harvest data can lead to erroneous conclusions. Therefore, total catch for each co-operative was determined by:

$$T.C. = \sum_{i=1}^{x} C_i$$

where: T.C. = total catch
C_i = catch per individual member of the co-operative as reported in the ADF&G fish ticket system.

Average catch per permit was then computed by:

$C^{\bar{}} = T.C./N$

where $C^{\bar{}}$ = mean catch/permit
N = the number of permits fishing in the co-operative.

All data were further grouped and averaged over approximately five mile (8 km) intervals of beach to examine geographical differences in catches.

RESULTS

In 1990, a total of 454 commercial salmon set gill net permit holders delivered salmon from the Upper Subdistrict fishery. A total of 197 permit holders, or approximately 43 percent of fishery participants returned questionnaires (Table 1). Average harvest per permit for those who returned the questionnaires was generally higher for all species than the average per permit from the fish ticket data base.

Commercial Harvest Total

Spatial harvest patterns for each statistical area in 1990 did not follow historical patterns. Between 1983 and 1986 Ninilchik Beach fishery (Figure 1) harvested between 15 and 30 percent of the Upper Subdistrict sockeye salmon (*O. nerka*) set gill net catch (Figure 3). From 1987 to the present the percentage of sockeye harvested has decreased to less than 10 percent. Concurrent increases were recorded in the Salamatof Beach fishery (Figure 4). Cohoe Beach (Figure 5) and Kalifonsky Beach (Figure 6) percentages remained fairly constant. These data were not available for Ninilchik Beach before 1983 because this statistical area had not been established.

During the 1990 season, Ninilchik Beach was opened for 224 hours of commercial fishing (16 days total). Sockeye and chinook salmon daily harvests (Figure 7 and 8) followed similar patterns of increasing harvests through late July, peaking on 27 and 31 July, respectively. A rapid decline was then observed to the end of the season on August 15. The coho salmon harvest (Figure 9) was low until 23 July then increased dramatically and remained strong through the end of the season (15 August).

Statistical Area 244-22, Cohoe Beach, was open concurrently with Ninilchik Beach. Daily sockeye and coho salmon harvests followed patterns similar to those observed for Ninilchik Beach (Figure 10 and 11). Daily chinook salmon harvests were variable (Figure 12). The average daily harvest for this beach was 55 chinook per day.

Statistical Area 244-30, Kalifonsky Beach, was open for commercial salmon fishing for 20 days (307 hrs). Daily sockeye and chinook salmon harvests were variable but remained much stronger than the more southerly beaches (Figures 13 and 14). Coho salmon harvests followed trends similar to the southern beaches (Figure 15).

Statistical area 244-40, Salamatof Beach, was opened concurrently with Kalifonsky Beach. Salamatof Beach had consistently stronger and less variable sockeye salmon harvest (Figure 16) than the three southern beaches. Daily chinook salmon harvests on Salamatof Beach (Figure 17) were slightly lower than on Kalifonsky Beach. Daily coho harvests (Figure 18) were highest on Salamatof Beach and began earlier, with fairly large catches on 16 July.

The total Upper Subdistrict sockeye salmon harvest by beach indicated a rapid increase in sockeye harvests from south to north (Figure 19). The same general trend was seen for coho salmon harvests (Figure 20), however, increases in catch were less dramatic south of Salamatof Beach. Chinook salmon harvests were just under 700 fish on both Cohoe and Ninilchik beaches, but rose to almost 1,600 fish on Kalifonsky Beach and 1,204 fish on Salamatof Beach (Figure 21).

Commercial Harvest per Permit

The total Upper Subdistrict sockeye salmon harvest per permit by beach, estimated from returned questionnaires, indicated the same rapid increase in catches from south to north (Figure 22). The chinook harvest per permit was slightly greater in the northern areas (Figure 23). Coho harvests were highest on Salamatof Beach and averaged 132 coho per permit (Figure 24). The remaining three areas, Kalifonsky, Cohoe and Ninilchik Beaches, averaged 50 to 60 coho per permit.

The spatial distribution of the sockeye salmon harvest, when grouped in five mile increments, indicated that lowest catches, 355 sockeye salmon per permit were made at Ninilchik. Harvests increased steadily, to a high a 5,300 sockeye salmon per permit, just north of the Kenai River mouth (Figure 25). Sockeye harvests then decreased to just over 2,000 sockeye per permit at the northern boundary of the Upper Subdistrict.

Chinook harvest per permit by five mile segments of beach did not exhibit the same pattern (Figure 26). Harvests fluctuated between 5 to 10 chinook per permit until just north of the Kenai River, where 20 chinook per permit were captured. Chinook harvests were lowest at the northern boundary.

Coho harvest per permit followed a similar pattern to the chinook harvest, fluctuating between 25 to 75 coho until north of the Kenai River (Figure 27). The greatest harvest, 200 coho salmon per permit, occurred near the Upper Subdistrict northern boundary (Figure 27).

The ratio of the number of sockeye per chinook salmon harvested was lowest, 37 to 1, at the southern boundary (Figure 28). This ratio increased to approximately 300 to 1 at the Kenai River. Ten miles north of the Kenai River few chinook were harvested. This increased the ratio to over 1400 to 1, the highest observed.

The ratio of sockeye to coho harvest per permit by five mile interval indicated that the Kalifonsky and Salamatof Beach areas harvest several times as many sockeye per coho as the southern beaches (Figure 29). Ratios of 30 to 50 sockeye salmon per coho were recorded for these areas. In contrast, southern fishing areas averaged less than 10 sockeye salmon per coho salmon .

Fishery Dynamics

Examination of salmon harvest rates between inshore and offshore nets was limited

to Kalifonsky Beach because of the amount of movement of nets inshore or offshore in other areas. Many fisherman south of the Kasilof River (Cohoe and Ninilchik Beaches) moved from inshore fishing locations to offshore locations as the season progressed. Limited returns from offshore areas on Salamatof Beach eliminated this area from analysis. Kalifonsky Beach data indicated that highest harvest levels per permit for all species, were within the first 1/2 mile increment from shore (Table 2). Lowest harvest levels, approximately 20 percent of the inshore increment, for all three species were experienced in the 1/2 to 1 mile increment. Harvest levels for the third interval, 1 mile to 1.5 miles offshore, were approximately 75 percent of the inshore area.

Examination of the distribution of mesh size used by Upper Subdistrict set gill net fishermen revealed that mesh size increased from south to north (Table 3). This was because the Salamatof Beach fishery targets on larger Kenai River sockeye salmon while the more southerly beaches also catch smaller Kasilof River sockeye salmon. Larger mesh sizes were also used in late July on the lower Beaches, although the reason for this could not be determined since few questionnaires were returned. Mesh size also appeared to increase from inshore to offshore locations, probably to target larger Kenai River sockeye.

Net depth, as measured in number of meshes, ranged from 32 to the legal maximum of 45 meshes. Depth of net increased from inshore to offshore net locations, so it appears that nets were as deep as water depth or regulations allowed.

Analysis of questionnaire returns, relative to gear movement between and within areas, indicated substantial movement on the lower beaches. Ninety one and 94 percent of the fishermen indicated they fished more than one, 1/2 mile interval along Cohoe and Ninilchik beaches, respectively. In contrast, on Salamatof Beach only 3% of the respondants indicated they fished in more than a single interval. On Kalifonsky Beach this figure was 31 percent.

Movement of gear between statistical areas was not commonly noted in returned questionnaires. No Ninilchik Beach fishermen indicated they fished other areas. Coho Beach fishermen indicated 13 percent of the permit holders moved between areas. Six percent of Kalifonsky Beach fishermen indicated they moved, while 10 percent moved from Salamatof Beach.

DISCUSSION

Results of the present investigation illustrate the complexity of the Upper Subdistrict set gill net fishery. Factors influencing results include the sample year, the geographic distribution of returned questionnaires, the large geographic area of the fishery, combined catches sold under one permit, and the mixed stock nature of the fishery.

Data for 1990 indicated that percent contribution of the harvest by beach was probably not typical of that normally observed prior to 1987. However, extremely poor catches of sockeye salmon on Ninilchik Beach combined with a reduced chinook salmon harvest served to maintain sockeye to chinook salmon catch ratios similar

to those observed by Tarbox et al. (1987). They found that the five year average sockeye to chinook salmon ratio on Ninilchik Beach ranged from 43 to 96. This was very close to the ratios observed in 1990.

The return of questionnaires may have biased the 1990 study, since it was extremely difficult to get questionnaires to offshore sites. For example, on Kalifonsky Beach there were very few recoveries in the second and third half mile intervals (Table 2). However, aerial observations of net locations indicated that nets were evenly distributed throughout this area (P. Ruesch, Alaska Department of Fish and Game, Soldotna, personal communication).

Recent controversy about the elimination of offshore nets may also have contributed to the lack of voluntary returns. Fisherman, feeling threatened, may have been unwilling to participate in data gathering activities that they perceived could be used to their disadvantage.

The distance between Ninilchik and Boulder Point is approximately 80 miles. While returned questionnaires represented 43% of the fishery the number of returns per unit of beach was fairly low. This decreased our ability to completely characterize offshore versus inshore harvest patterns and gear movement. In general, the substantial movement of gear on Ninilchik and Coho beaches made inshore to offshore harvest analyses impossible. Fish ticket harvest data were reported as daily catch by statistical area, so it could not be used to examine this issue.

Tarbox et al. (1987) indicated "there is no panacea to the current conflict over chinook salmon versus sockeye salmon harvest through elimination of commercial fishing operations in specific geographical area." With the exception of fishing sites located 20 - 25 miles south of the Kasilof River, the ratio of sockeye to chinook salmon was similar to the five year average reported by Tarbox et al. (1987).

In contrast to chinook salmon, there were no historical data with which to compare the 1990 observations on coho salmon. The pattern of extremely low sockeye to coho catches on southern beaches suggested that some regulatory option may be available to protect coho salmon. Ninilchik and Cohoe beach fishermen averaged between 60 and 100 coho per permit (Figure 24). In addition, coho salmon catch was increasing in early August while sockeye harvest was falling dramatically (Figures 7, 9-11). The increasing pink salmon (*O. gorbuscha*) harvest on the lower beach during this same time period, however will complicate regulatory action during dominant (even) years. In odd years earlier season closing dates may be appropriate.

In conclusion, the complexity of the Upper Subdistrict set gill net fishery makes quantification and analysis of the mechanics of this fishery difficult. The number of variables impacting the fishery requires intensive sampling to define cause and effect relationships. Indirect assessment through questionnaires will not address inshore to offshore harvest rates because of gear movement. Therefore, ground surveys will be required. However, the low harvest rates of chinook and coho salmon per permit will require significant effort to statistically define fishing patterns and relationships.

LITERATURE CITED

Tarbox, K., J. Browning, and R. Davis. 1987. Geographical distribution of sockeye salmon (Oncorhynchus nerka) and chinook salmon (O. tshawytscha) harvest by Upper Subdistrict set nets, Upper Cook Inlet, Alaska, 1978-1982. Alaska Department of Fish and Game, Technical Data Report No. 195, Juneau.

ADF&G (Alaska Department of Fish and Game). 1989. 1989-1990 Cook Inlet and Prince William Sound Commercial Finfish Regulations Salmon and Miscellaneous Finfish, Alaska Department of Fish and Game, Division of Commercial Fisheries, Juneau.

Table 1. Average salmon harvest per permit in the Upper Cook Inlet, Upper Subdistrict set gill net fishery, 1990.

Total Fish Ticket Data

				Harvest by permit					
Beach	Stat Area	Permits		Chinook	Sockeye	Coho	Pink	Chum	Total
Ninilchik	244-21	97		7.1	477.5	59.9	176.4	2.7	723.6
Cohoe	244-22	125		5.4	1,218.7	57.7	386.9	3.4	1,672.1
Kalifonsky	244-30	179		8.8	2,376.5	50.5	377.9	1.1	2,814.7
Salamatof	244-40	159		7.6	3,100.2	115.0	580.6	23.5	3,826.8
	Total	454	Average	7.2	1,793.2	70.8	380.4	7.7	2,259.3

Total Questionnaire Survey Data

		Number of	Percent Surveys	Harvest by permit					
Beach	Stat Area	Permits	Returned	Chinook	Sockeye	Coho	Pink	Chum	Total
Ninilchik	244-21	47	48%	7.3	480.9	60.8	185.5	3.2	737.7
Cohoe	244-22	35	28%	7.4	1,282.7	87.8	570.8	3.3	1,952.0
Kalifonsky	244-30	52	29%	9.2	2,108.9	54.7	372.6	0.8	2,546.2
Salamatof	244-40	63	40%	11.6	4,088.8	131.9	808.1	23.5	5,063.9
	Total	197	43%						
		Average		8.9	1,990.3	83.8	484.3	7.7	2,574.9

Table 2. Offshore distribution of the salmon harvest on Kalifonsky Beach, per permit, from a permit location questionnaire, 1990

	Number Permits	Chinook Per Permit	Percent of Total Chinook Harvest	Sockeye Per Permit	Percent of Total Sockeye Harvest	Coho Per Permit	Percent of Total Coho Harvest
Shore to 0.5 Mile	14	8.5	45.0%	2,527	50.5%	55	57.9%
0.5 Mile to 1 Mile	4	2.8	14.8%	536	10.7%	15	15.8%
1 Mile to 1.5 Miles	16	7.6	40.2%	1,944	38.8%	25	26.3%

Table 3. Mesh size used in the Upper Cook Inlet, Upper Subdistrict set gill net fishery, 1990.

		Mesh Size In Inches									
Beach	Stat Area	4.5	4.625	4.75	4.875	5	5.125	5.25	5.375	5.5	5.625
Ninilchik	244-21	0	36	9	64	21	6	0	0	0	0
Cohoe	244-22	4	0	23	1	21	35	20	4	0	0
Kalifonsky	244-30	0	0	0	29	6	35	71	0	0	9
Salamatof	244-40	0	0	0	0	17	31	48	77	5	4

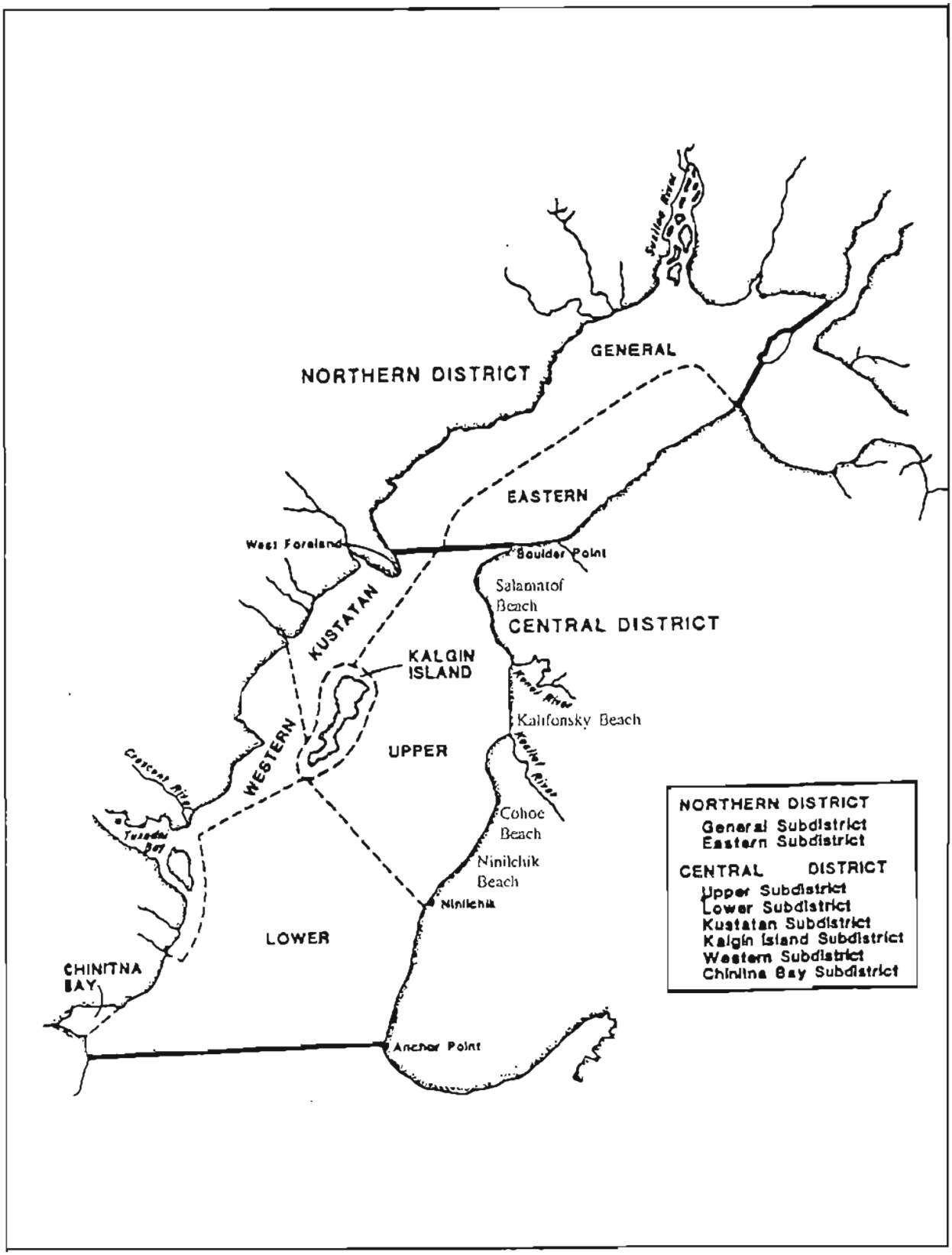

Figure 1. Map of Upper Cook Inlet.

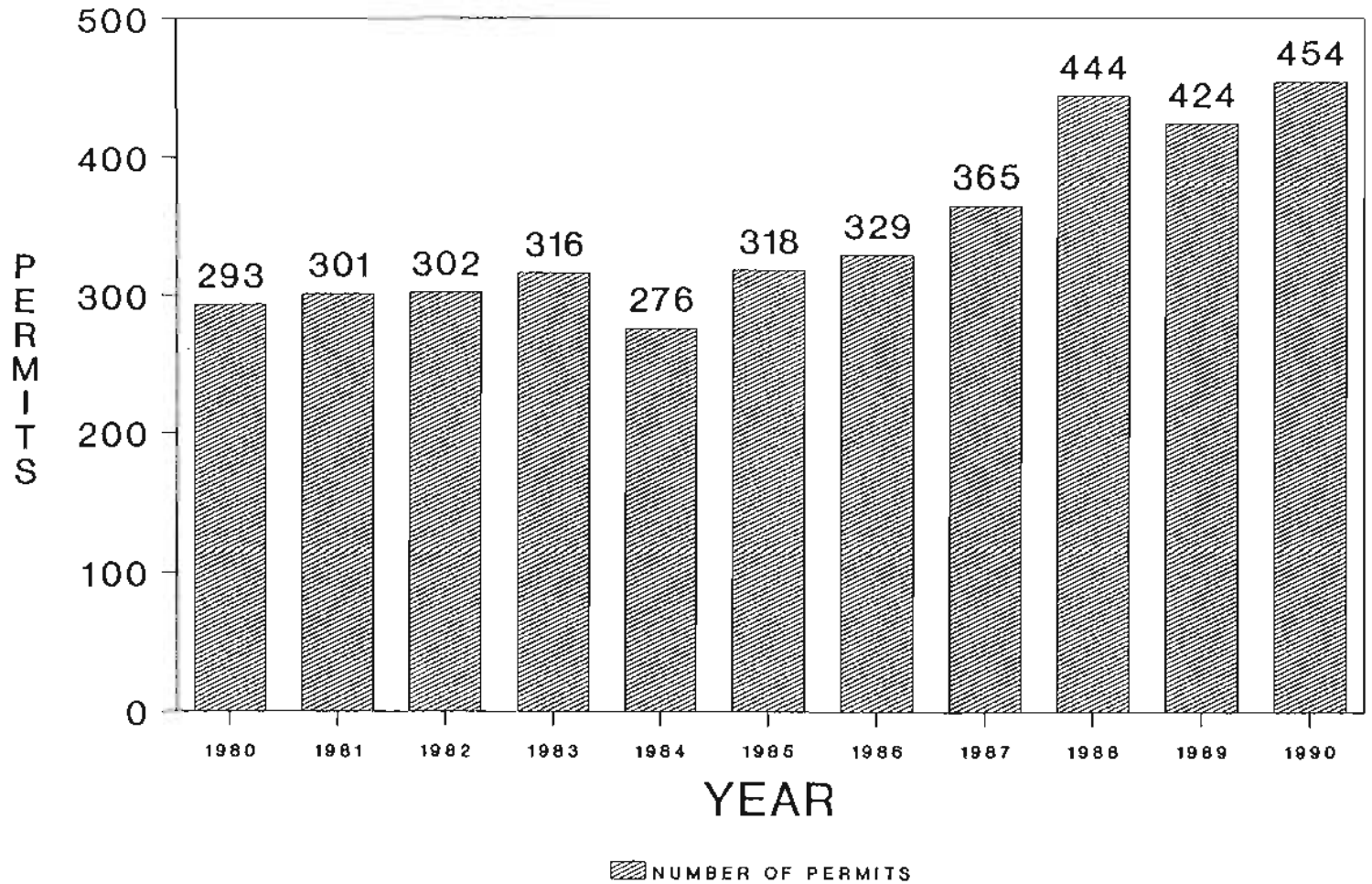

Figure 2. Number of Upper Subdistrict set gill net permits which sold fish between, 1980 - 1990.

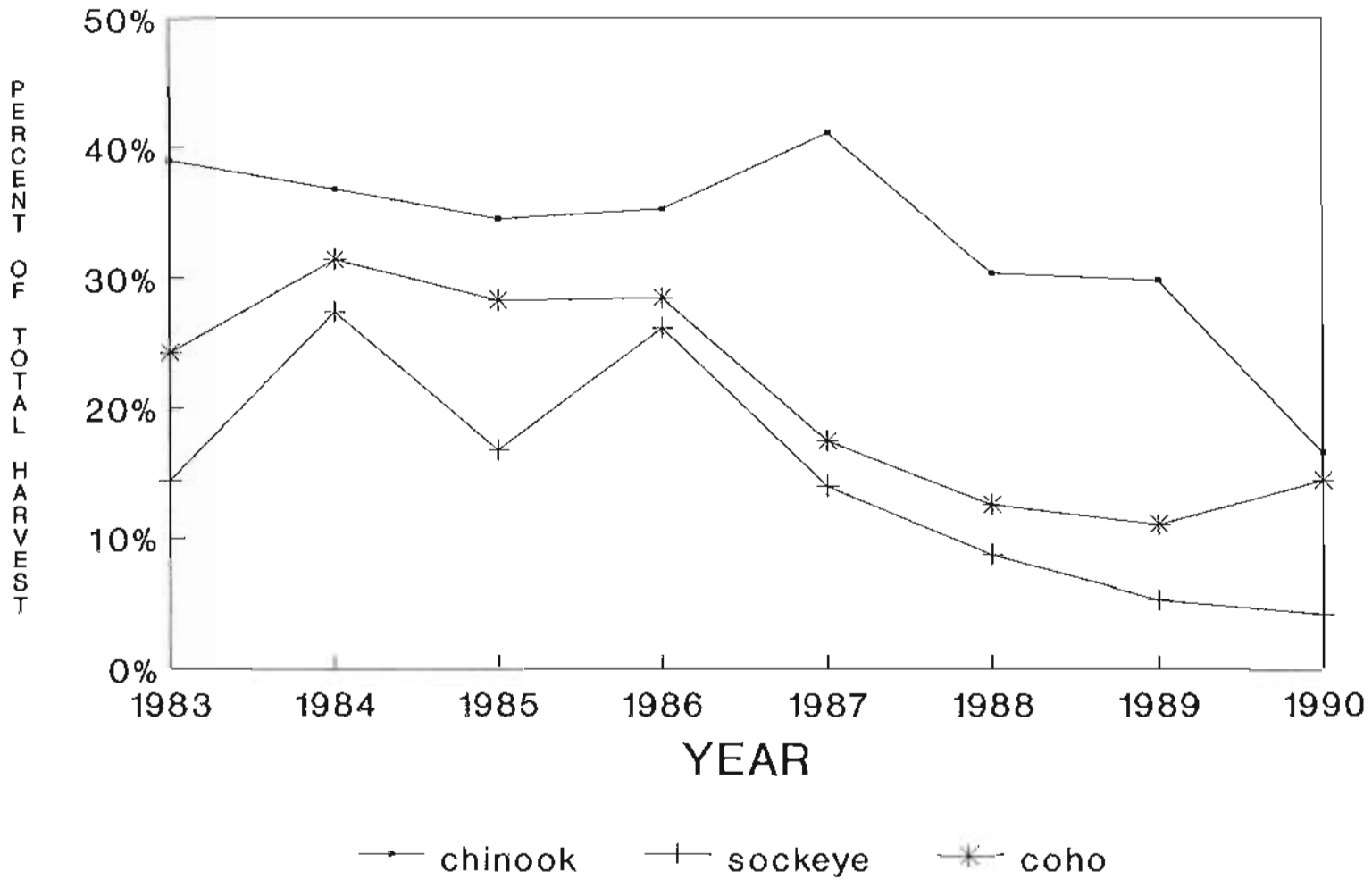

Figure 3. Percentage of the Upper Subdistrict Total Harvest by Species, Ninilchik Beach, 1983 to 1990.

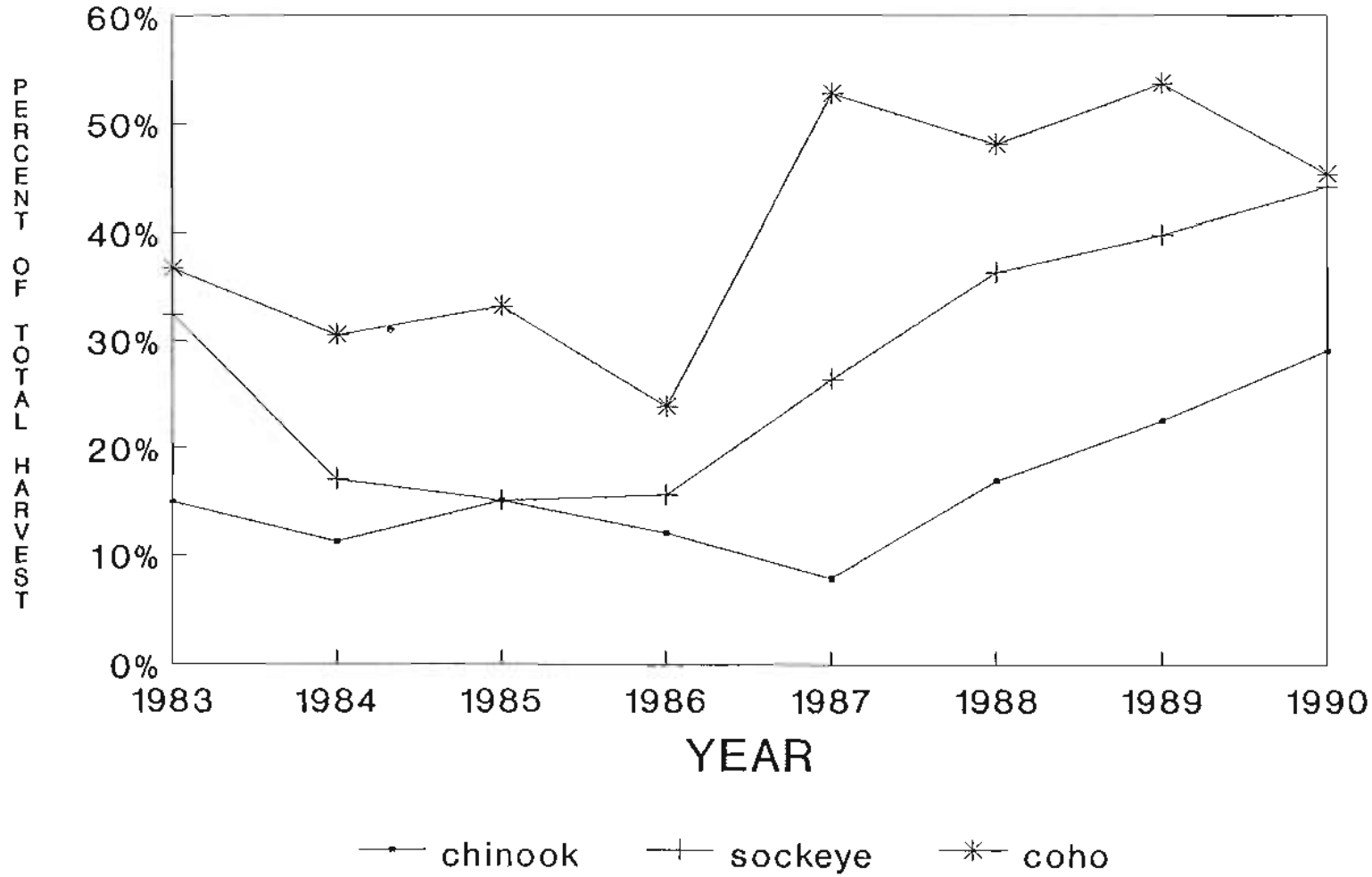

Figure 4. Percentage of the Upper Subdistrict Total Harvest by Species, Salamatof Beach, 1983 to 1990.

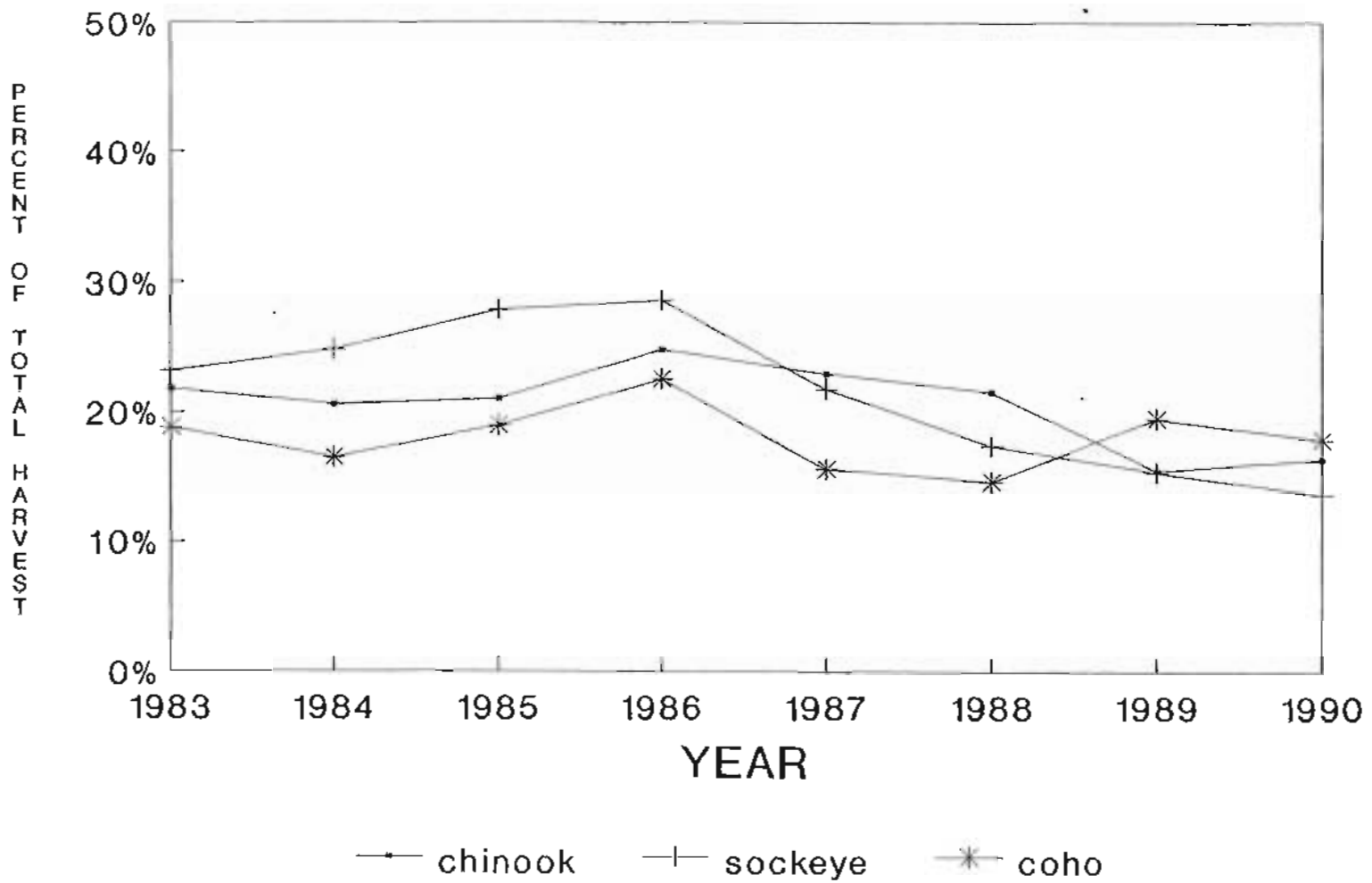

Figure 5. Percentage of the Upper Subdistrict Total Harvest by Species, Cohoe Beach, 1983 to 1990.

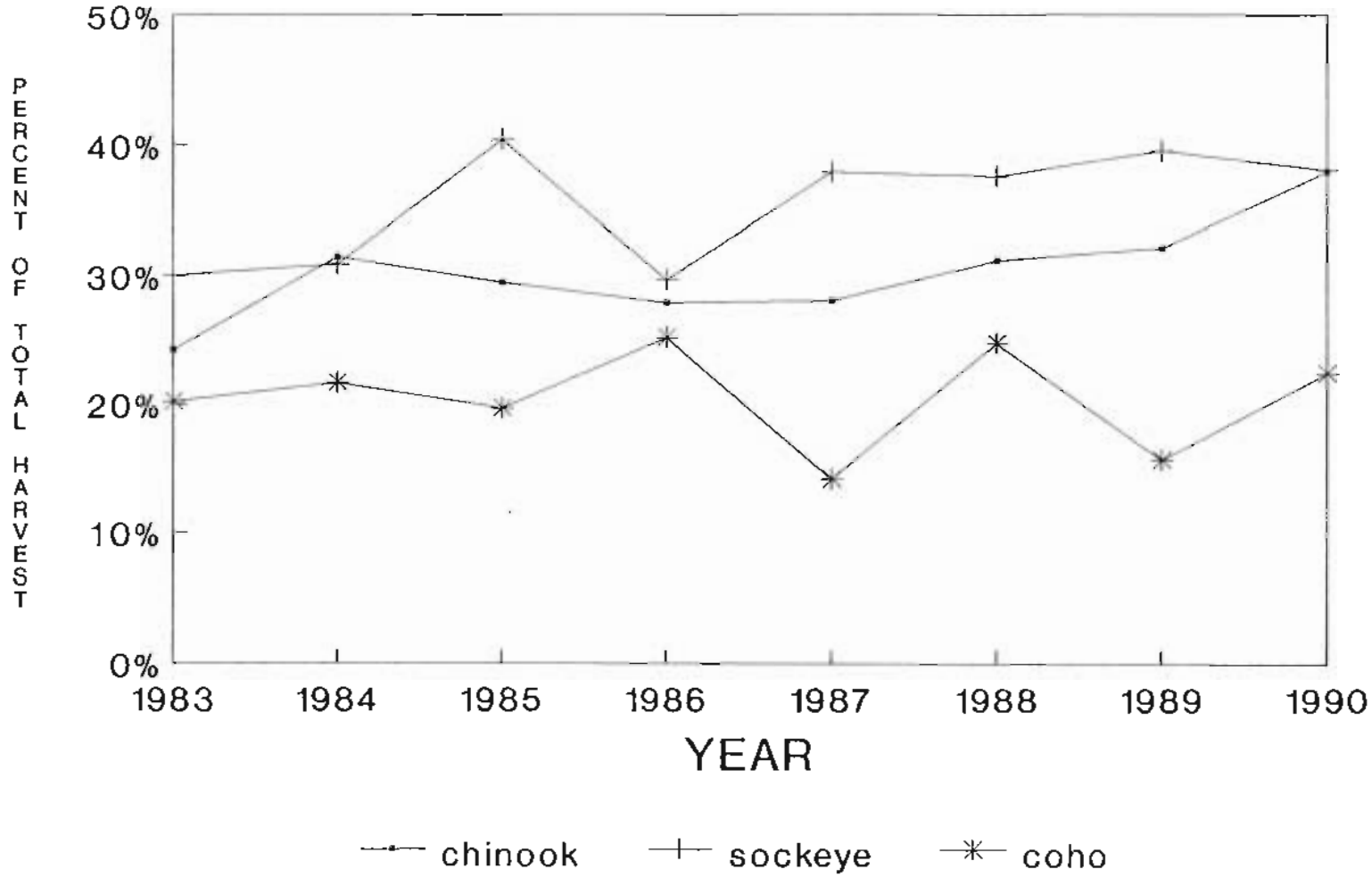

Figure 6. Percentage of the Upper Subdistrict Total Harvest by Species, Kalifonsky Beach, 1983 to 1990.

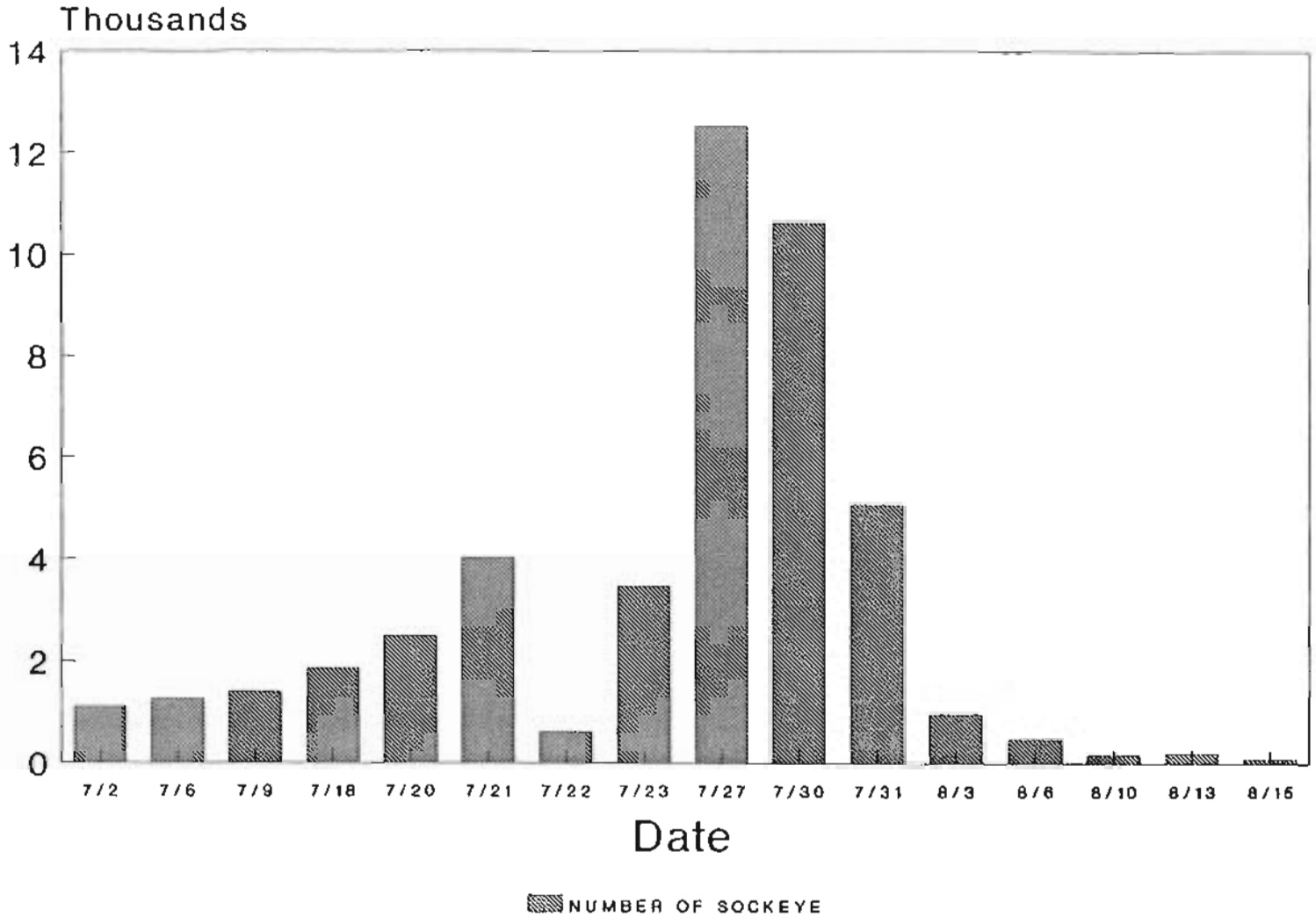

Figure 7. Daily Sockeye Salmon Harvest by Set Gill Net, Ninilchik Beach, 1990.

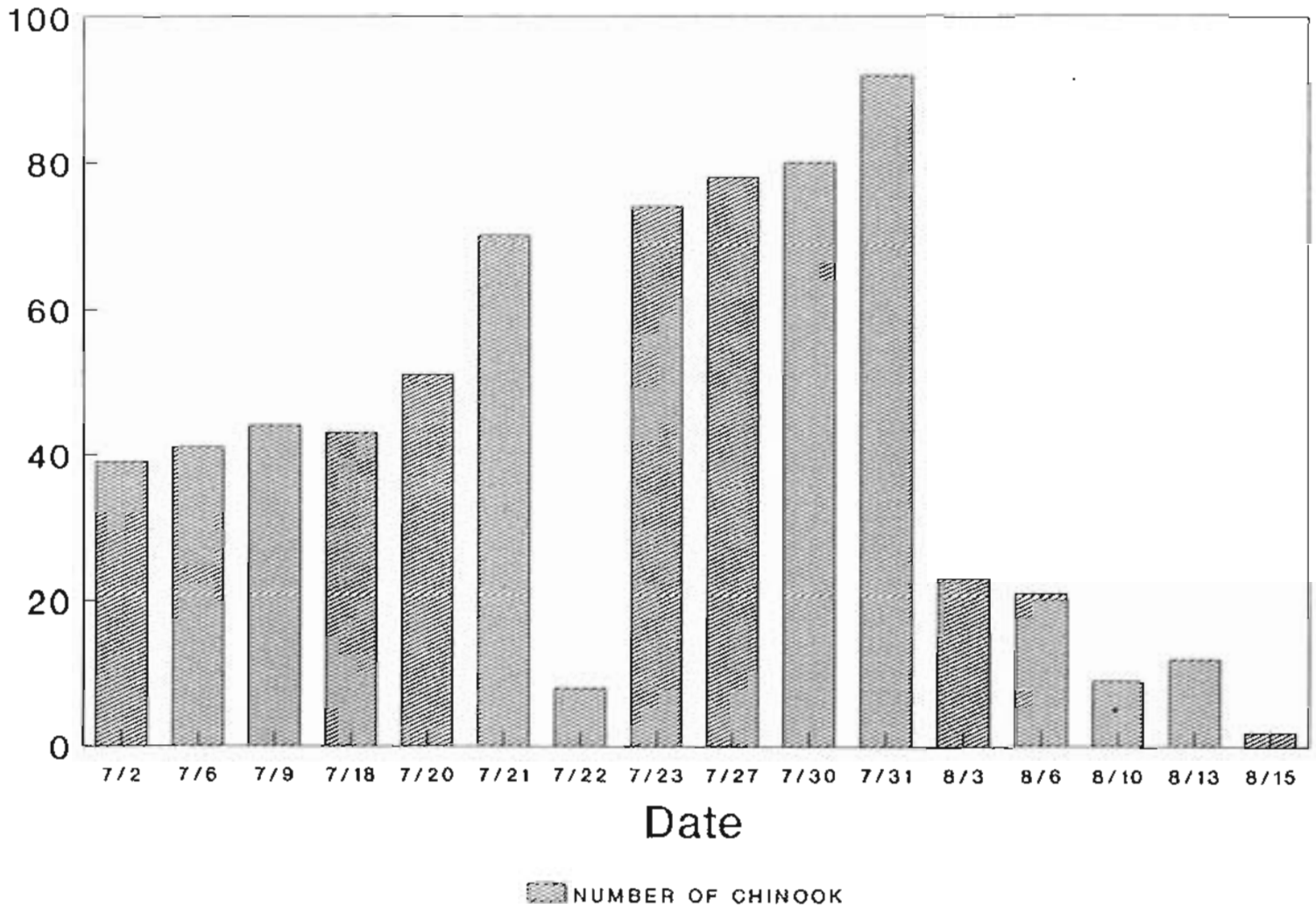

Figure 8. Daily Chinook Salmon Harvest by Set Gill Net, Ninilchik Beach, 1990.

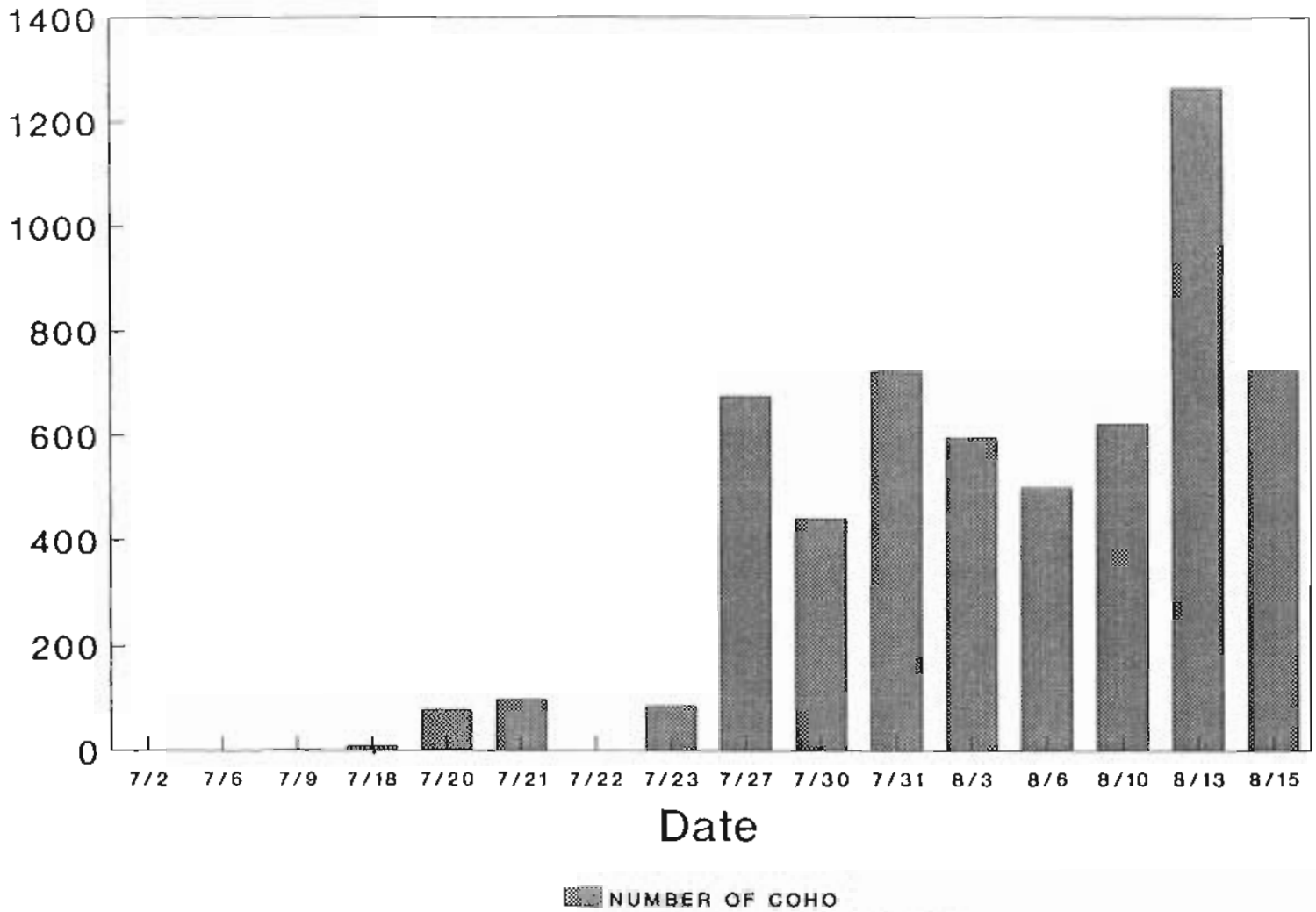

Figure 9. Daily Coho Salmon Harvest by Set Gill Net, Ninilchik Beach, 1990.

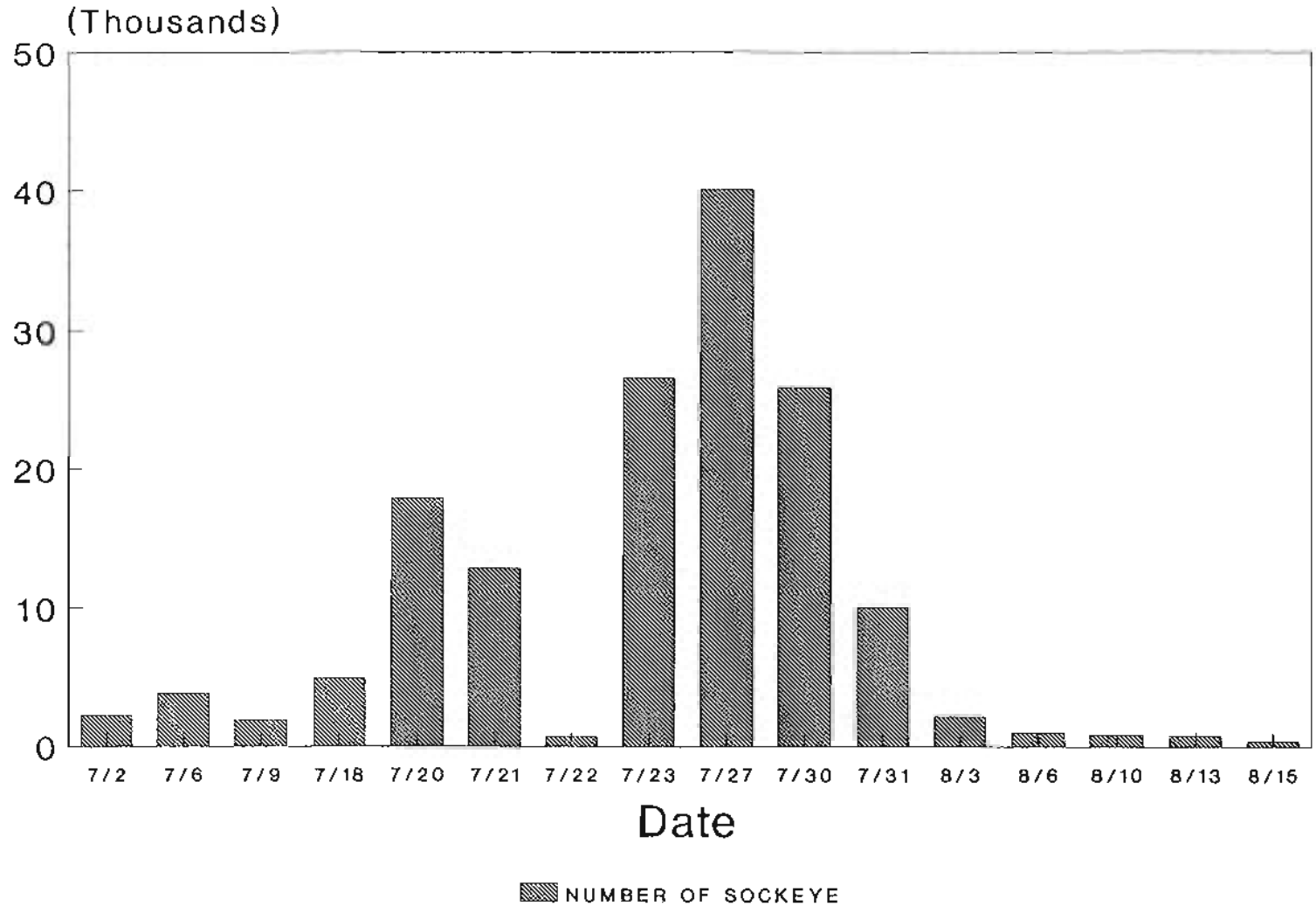

Figure 10. Daily Set Gill Net Sockeye Salmon Harvest, Cohoe Beach, 1990.

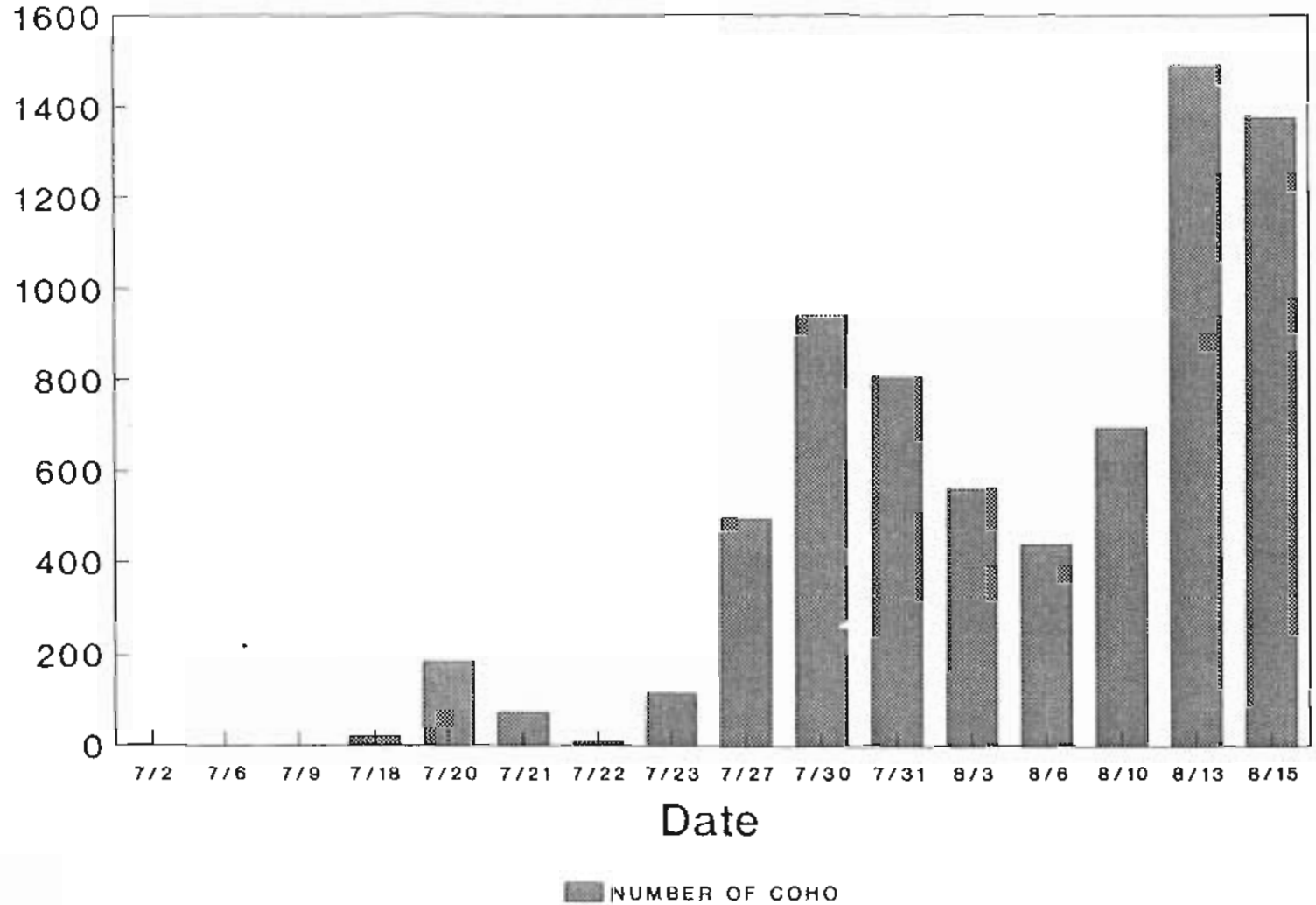

Figure 11. Daily Set Gill Net Coho Salmon Harvest, Cohoe Beach, 1990.

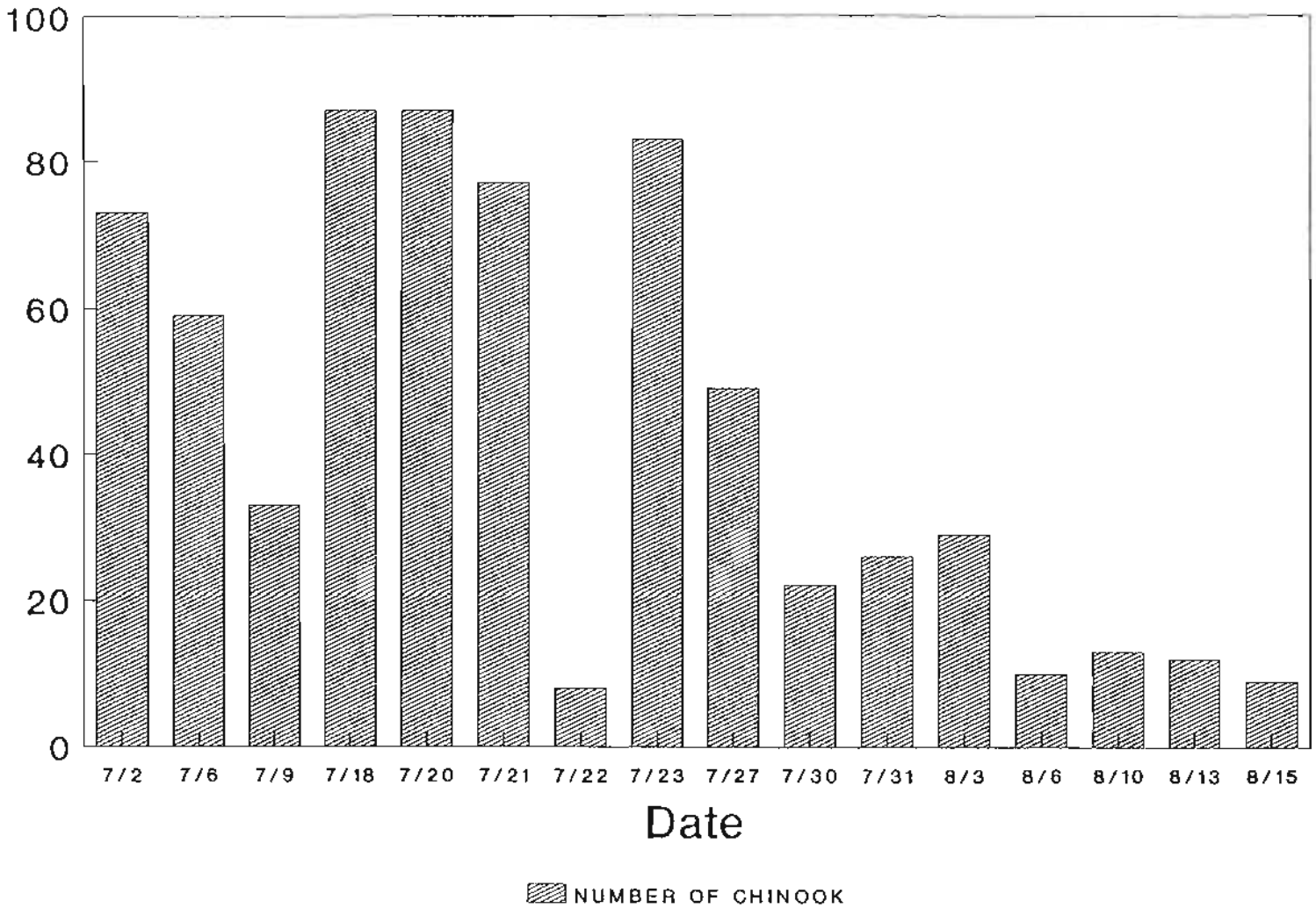

Figure 12. Daily Set Gill Net Chinook Salmon Harvest, Cohoe Beach, 1990.

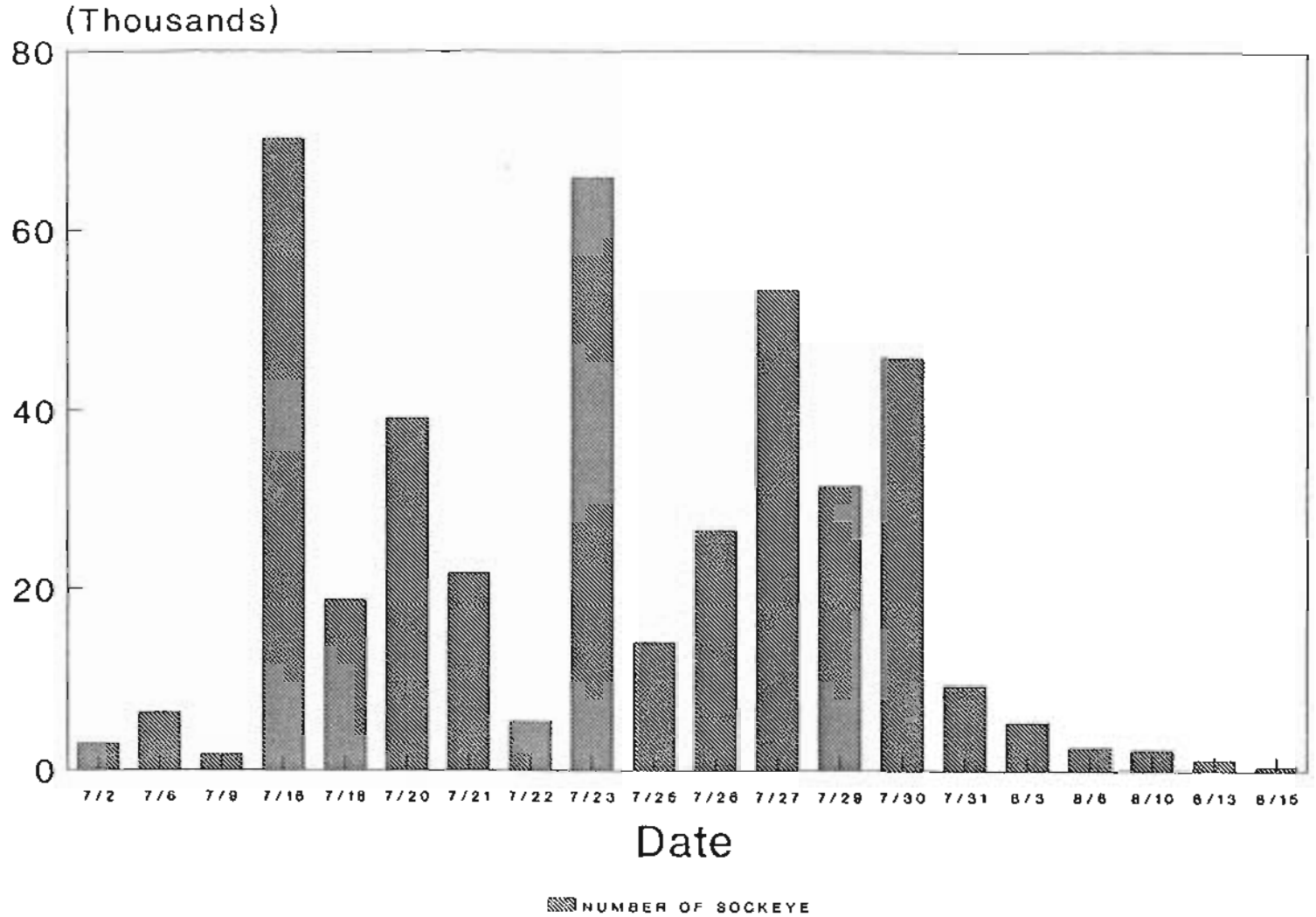

Figure 13. Daily Set Gill Net Sockeye Salmon Harvest, Kalifonsky Beach, 1990.

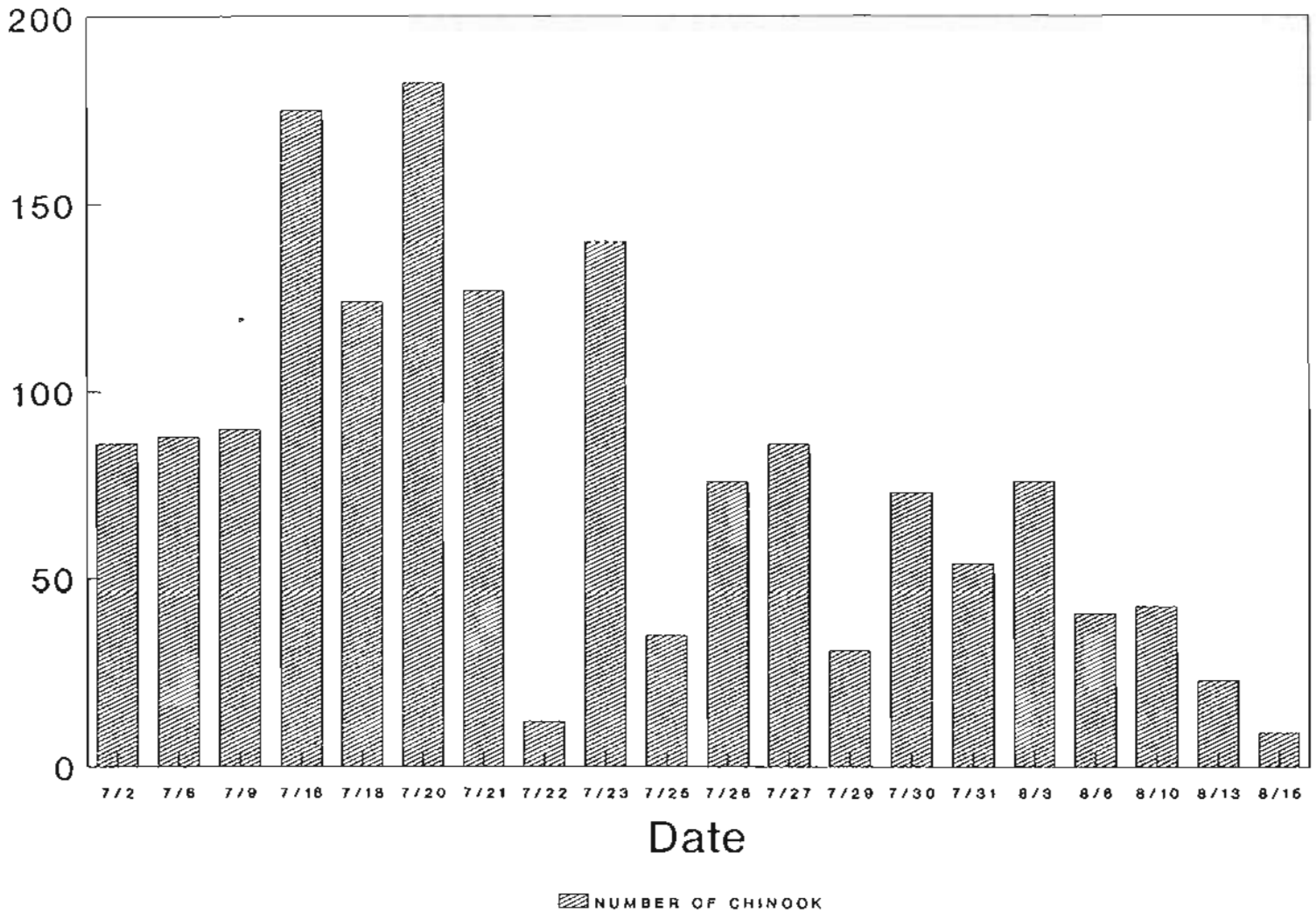

Figure 14. Daily Set Gill Net Chinook Salmon Harvest, Kalifonsky Beach, 1990.

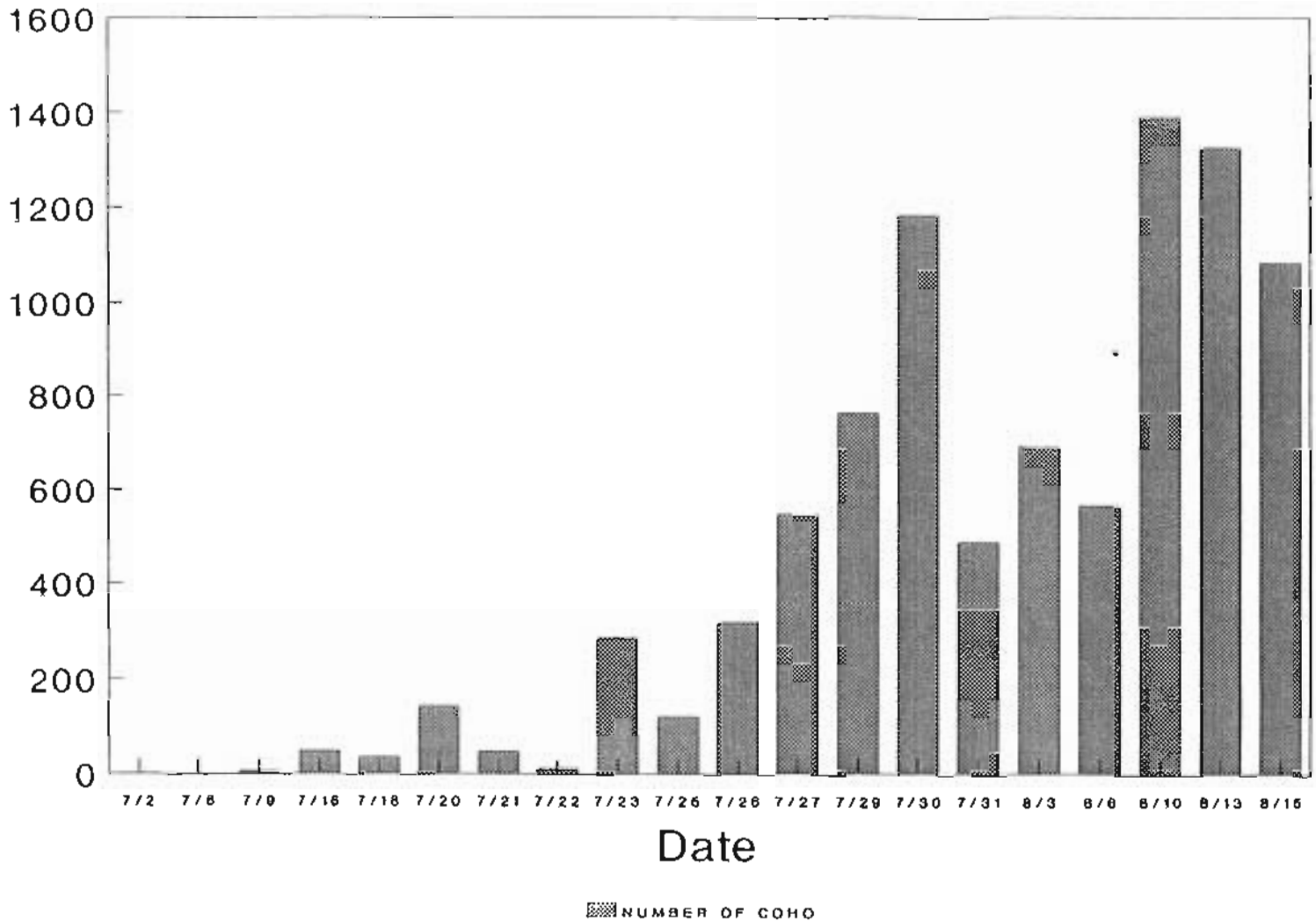

Figure 15. Daily Set Gill Net Coho Salmon Harvest, Kalifonsky Beach, 1990.

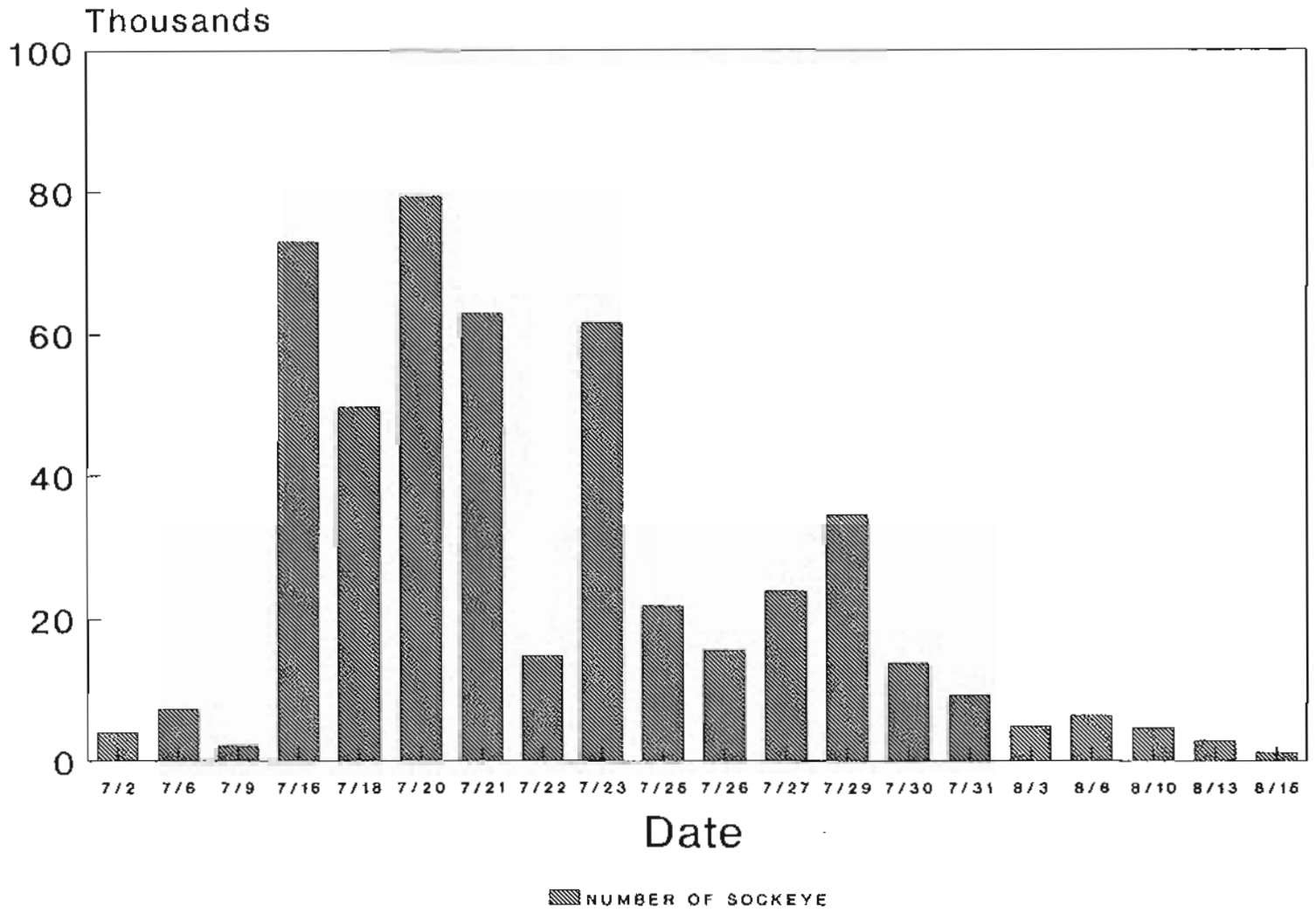

Figure 16. Daily Set Gill Net Sockeye Salmon Harvest, Salamatof Beach, 1990.

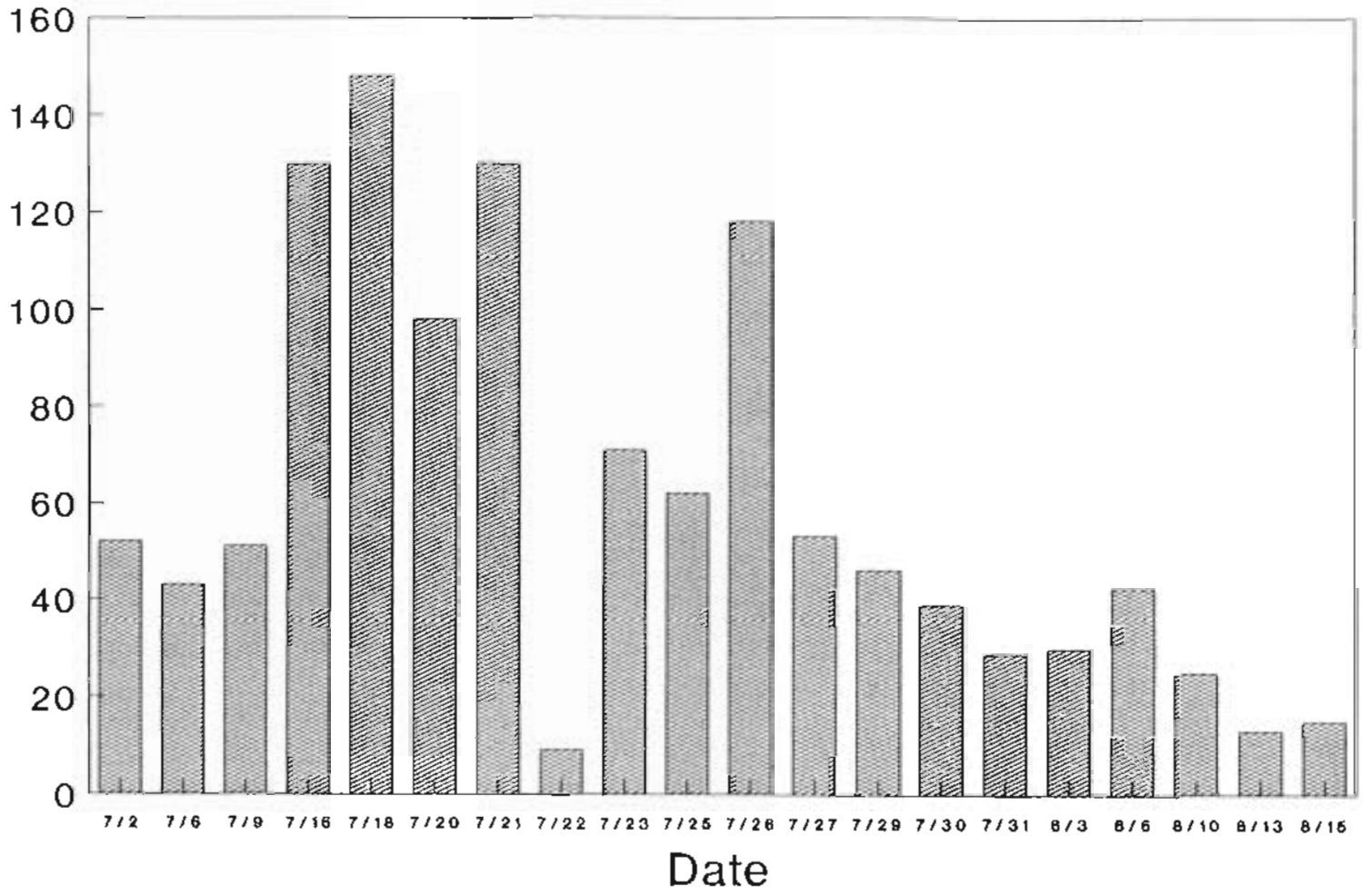

Figure 17. Daily Set Gill Net Chinook Salmon Harvest, Salamatof Beach, 1990.

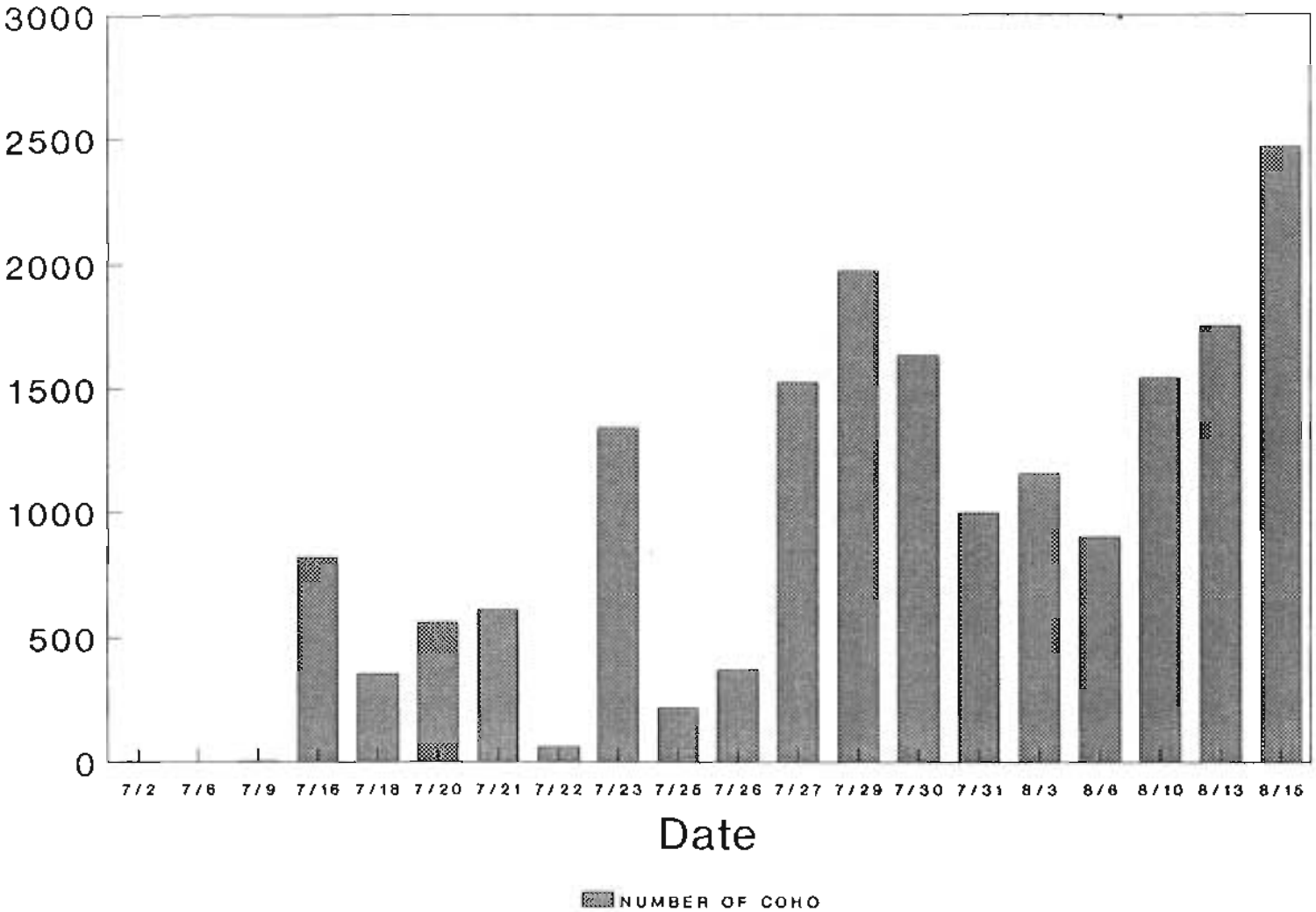

Figure 18. Daily Set Gill Net Coho Salmon Harvest, Salamatof Beach, 1990.

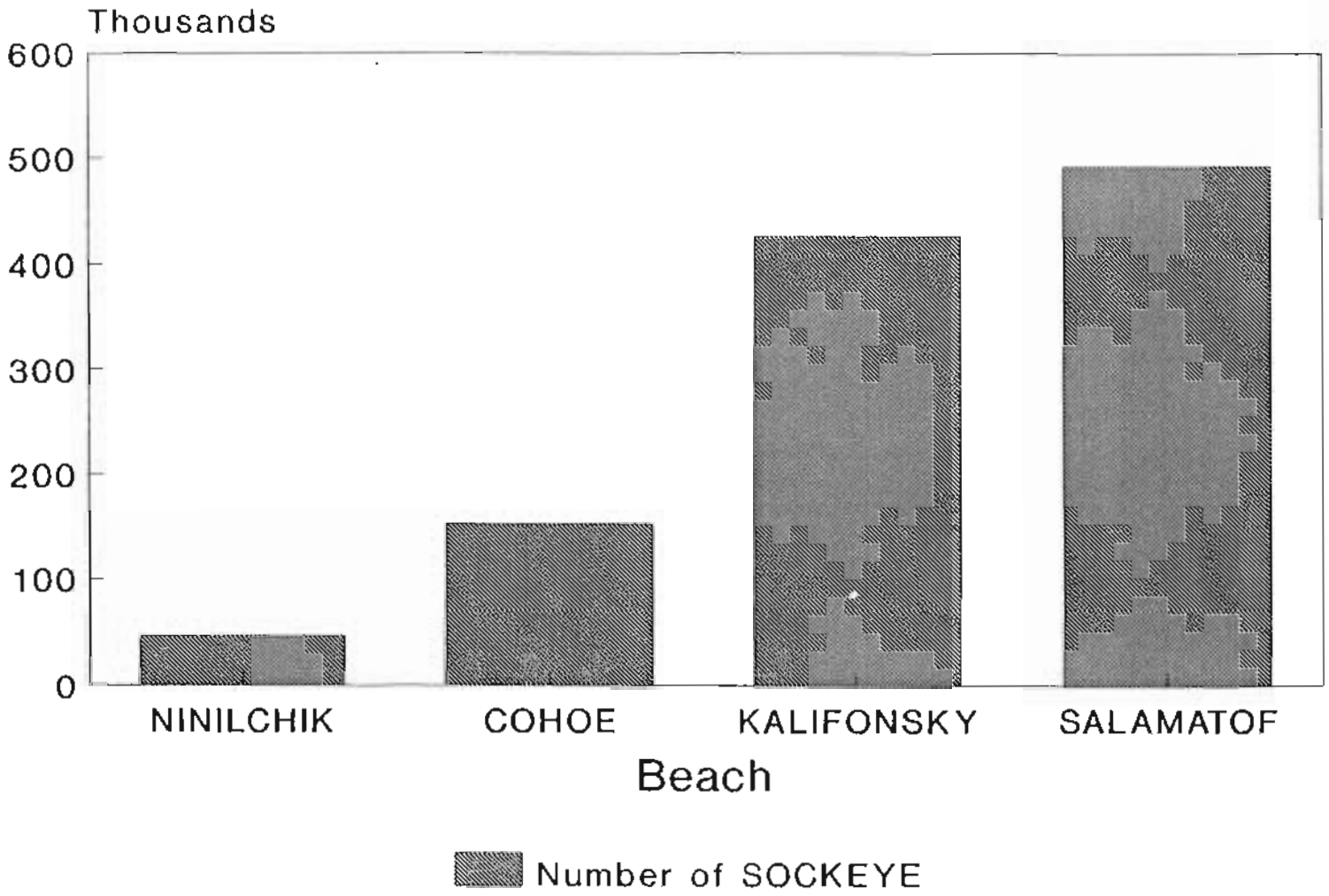

Figure 19. Sockeye Salmon Harvest by Beach, Upper Subdistrict, 1990.

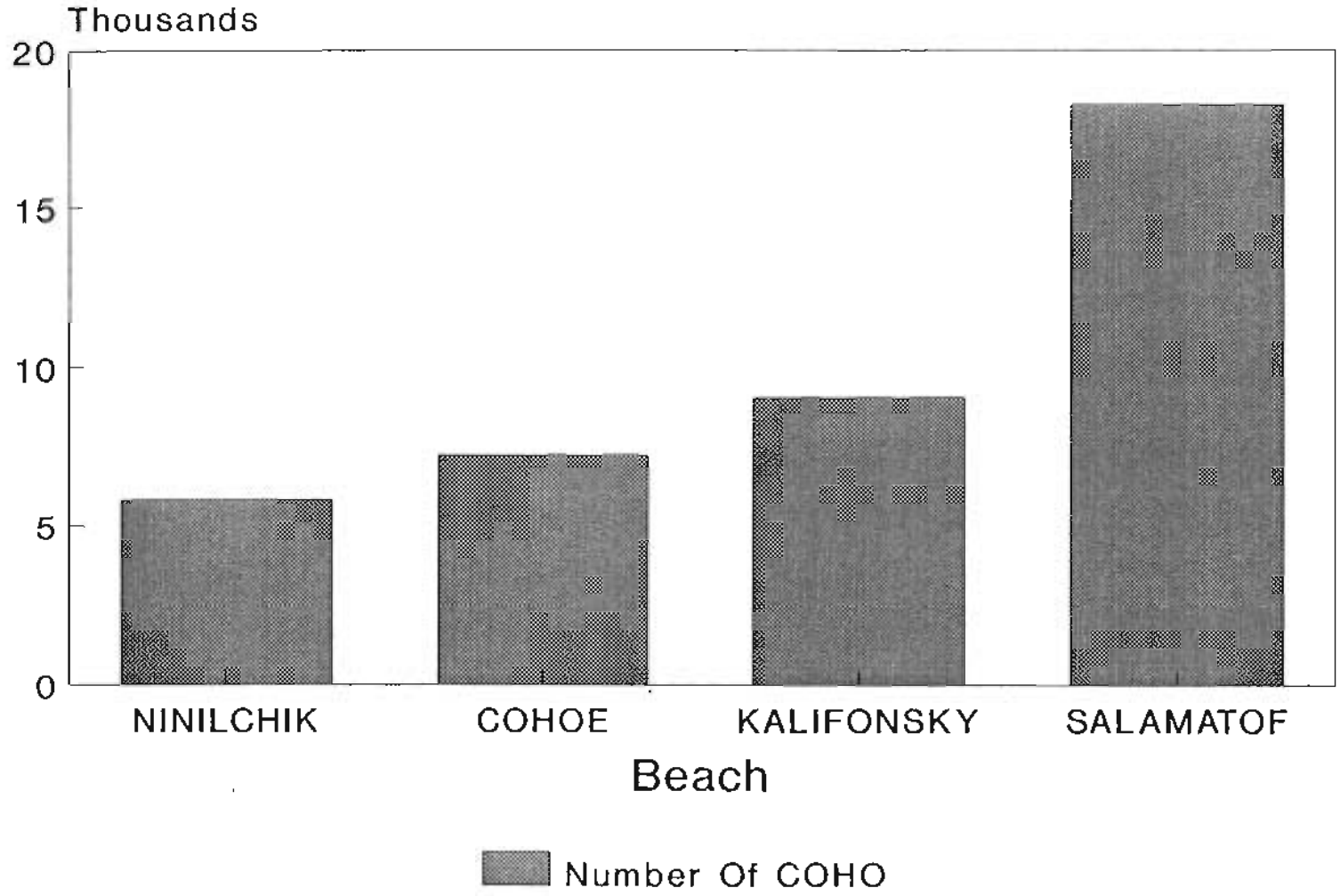

Figure 20. Coho Salmon Harvest by Beach, Upper Subdistrict, 1990.

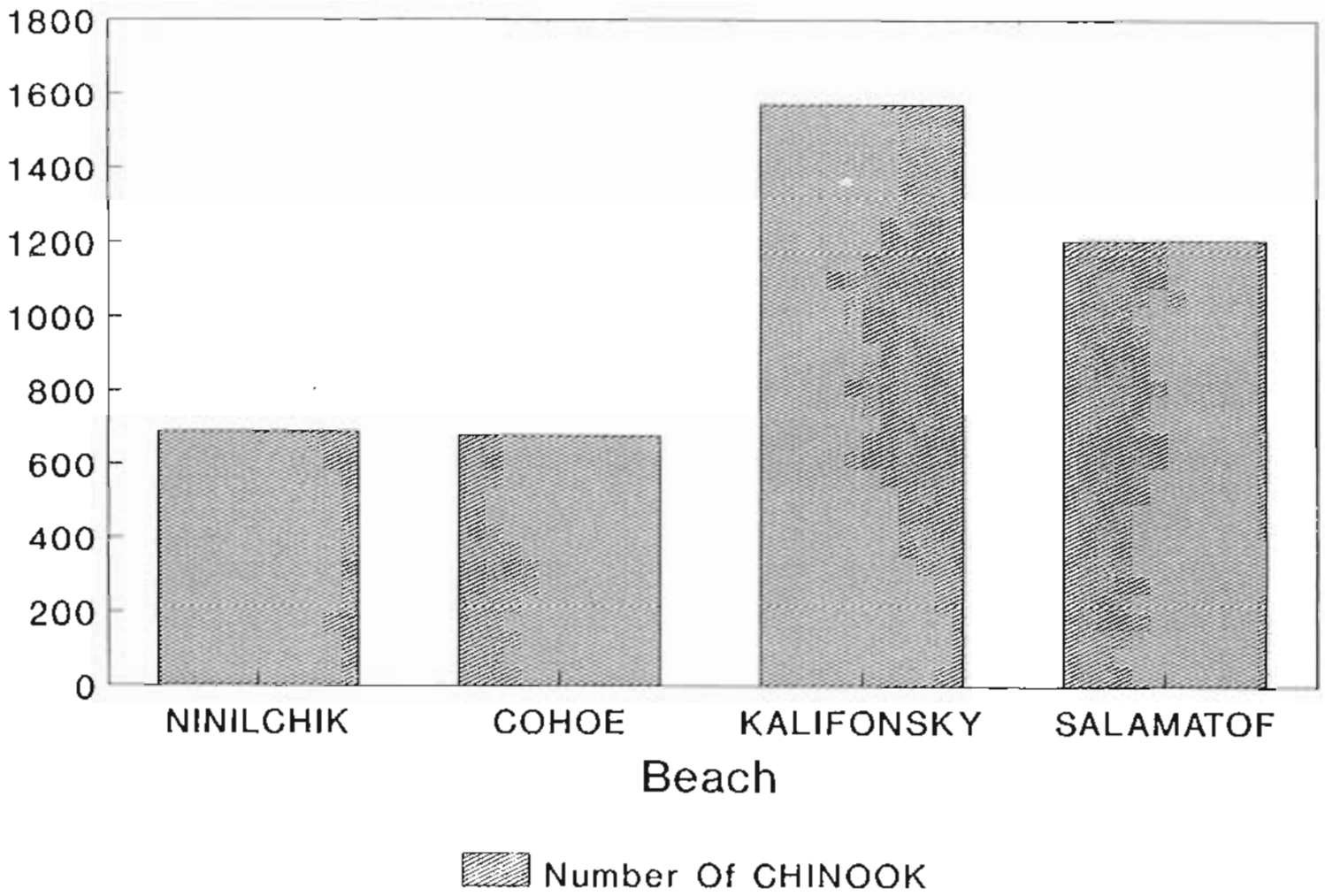

Figure 21. Chinook Salmon Harvest by Beach, Upper Subdistrict, 1990.

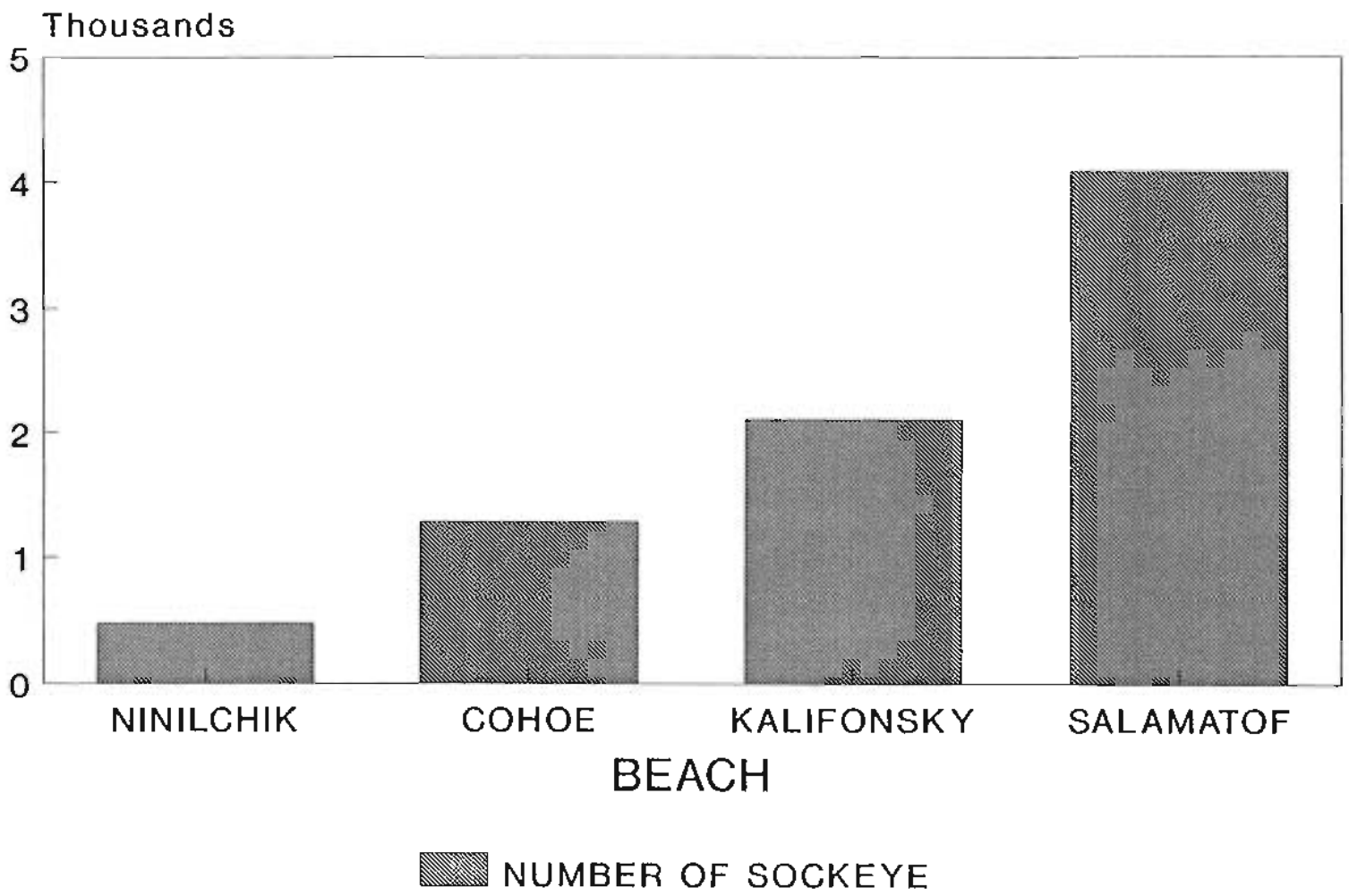

Figure 22. Sockeye Salmon Harvest Per Permit, by Beach, 1990, From a Harvest Location Questionnaire.

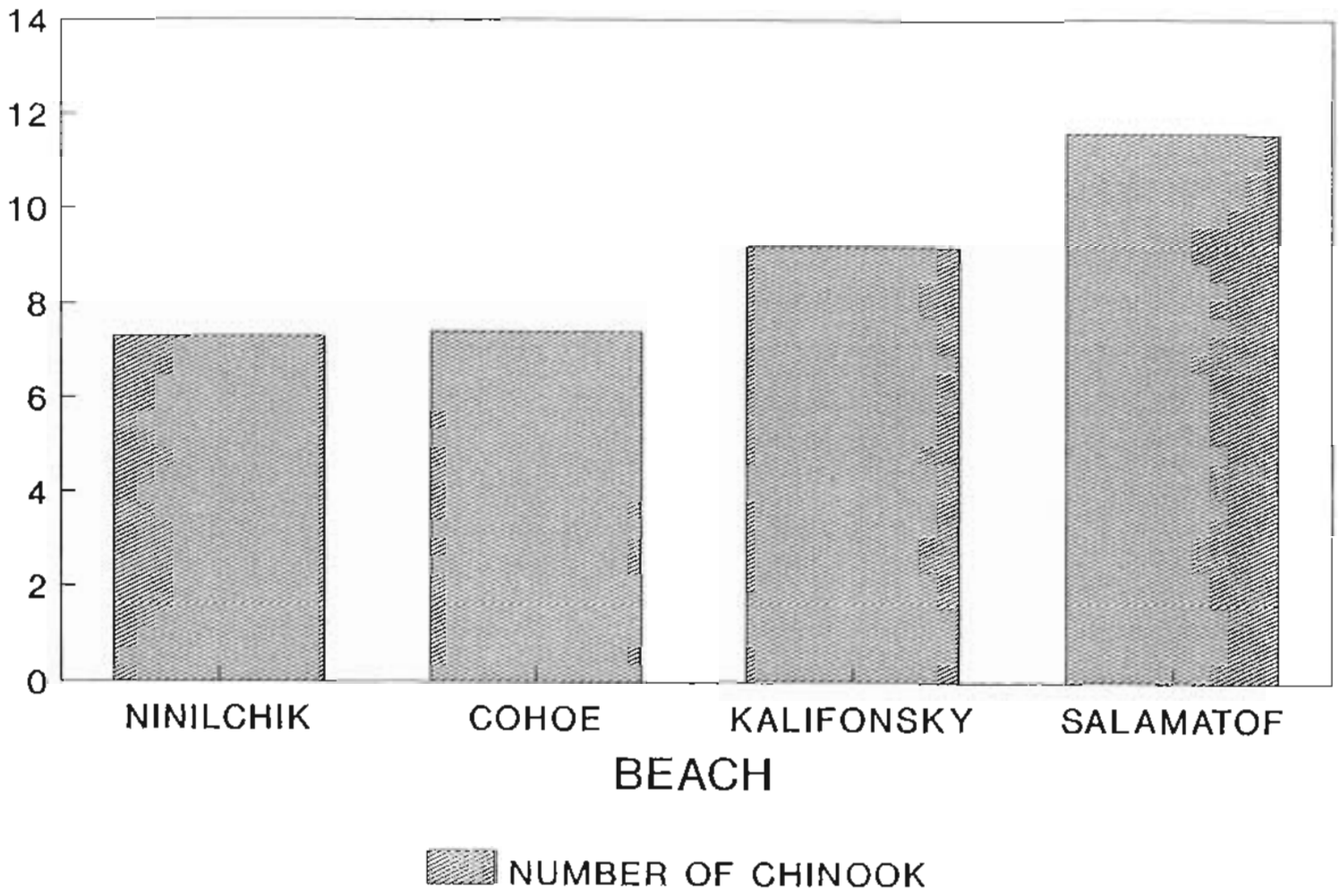

Figure 23. Chinook Salmon Harvest Per Permit, by Beach, 1990, From a Harvest Location Questionnaire.

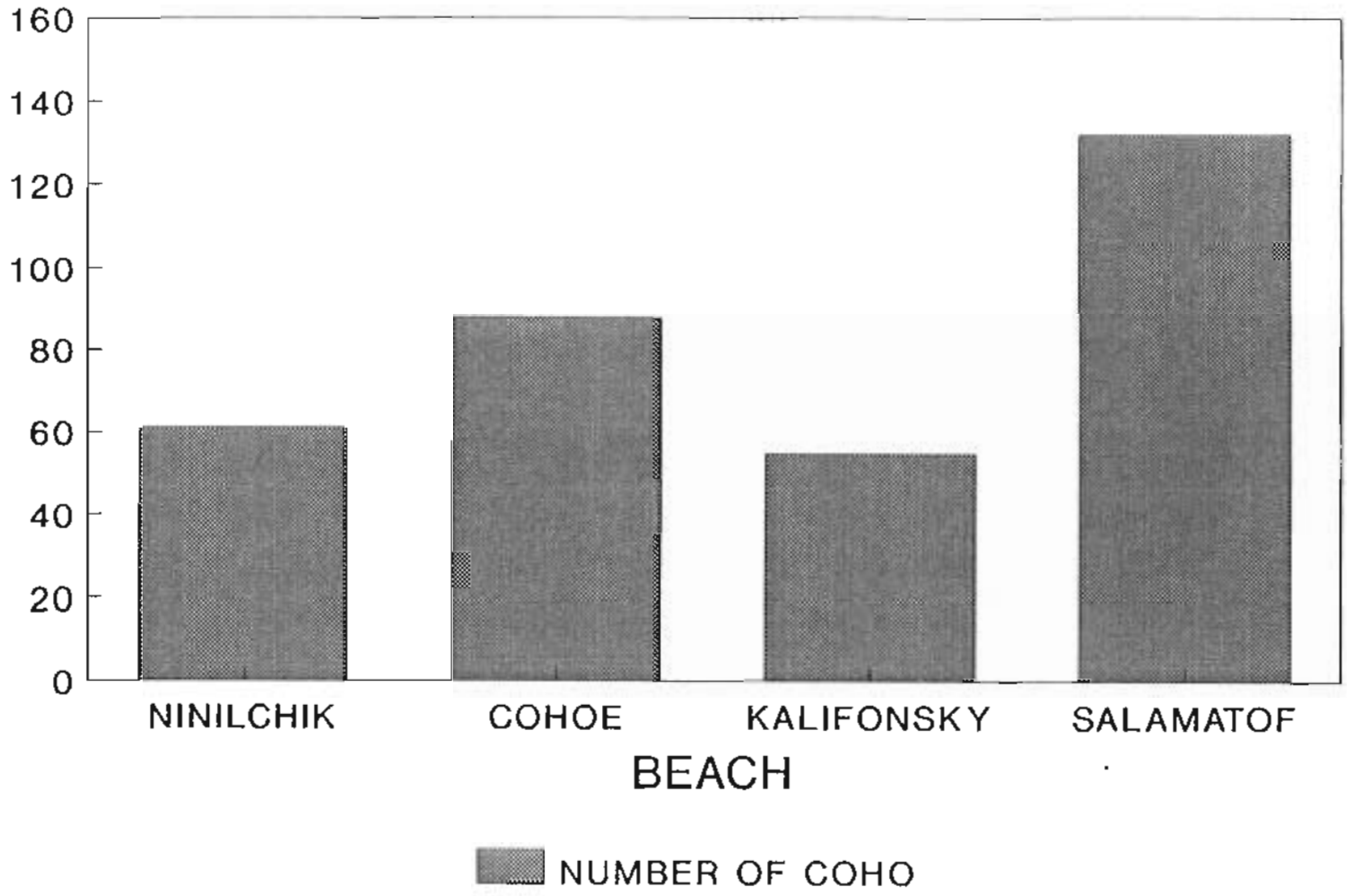

Figure 24. Coho Salmon Harvest Per Permit, by Beach, 1990, From a Harvest Location Questionnaire.

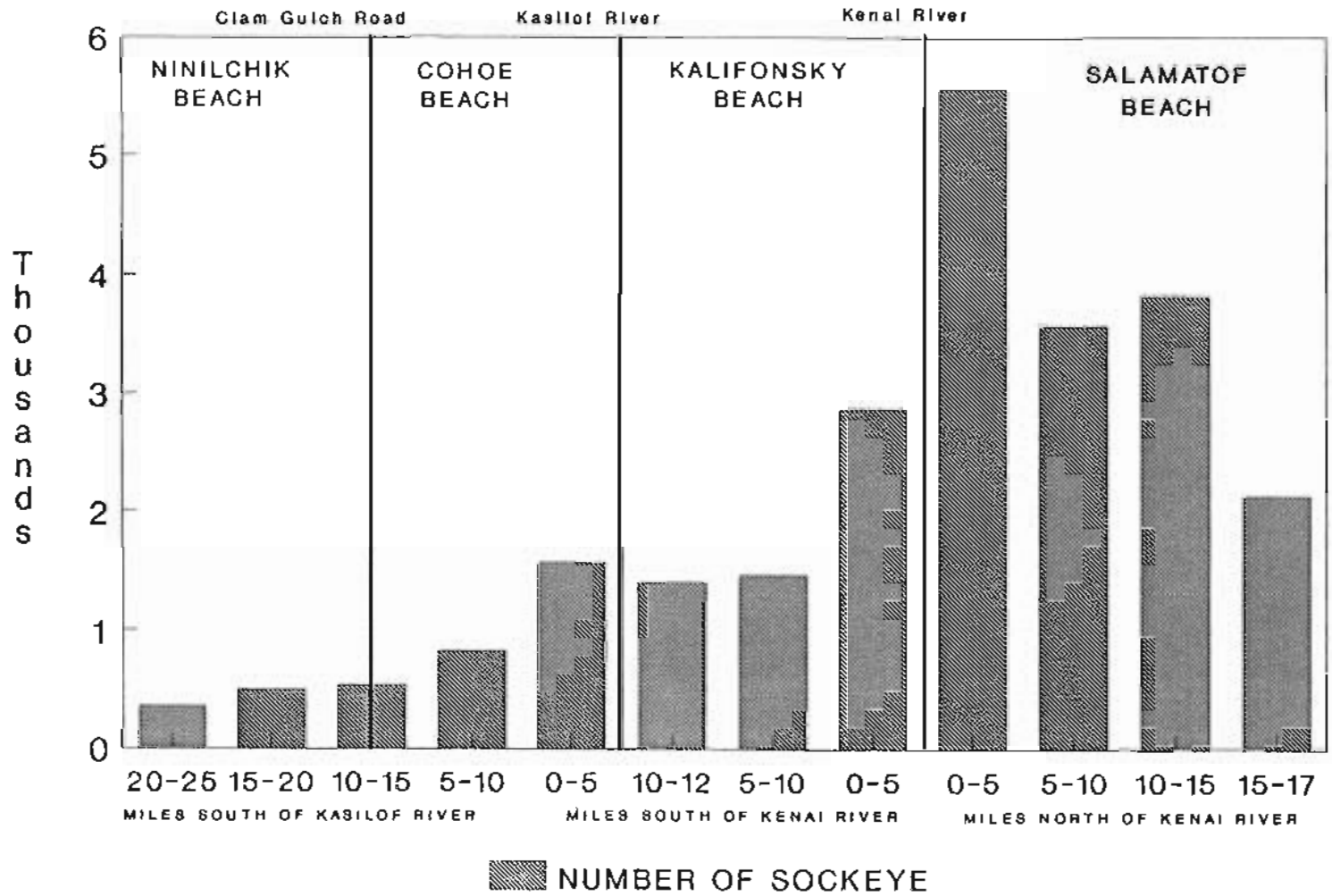

Figure 25. Upper Subdistrict Sockeye Salmon Harvest Per Permit by Mile Interval, by Beach, 1990.

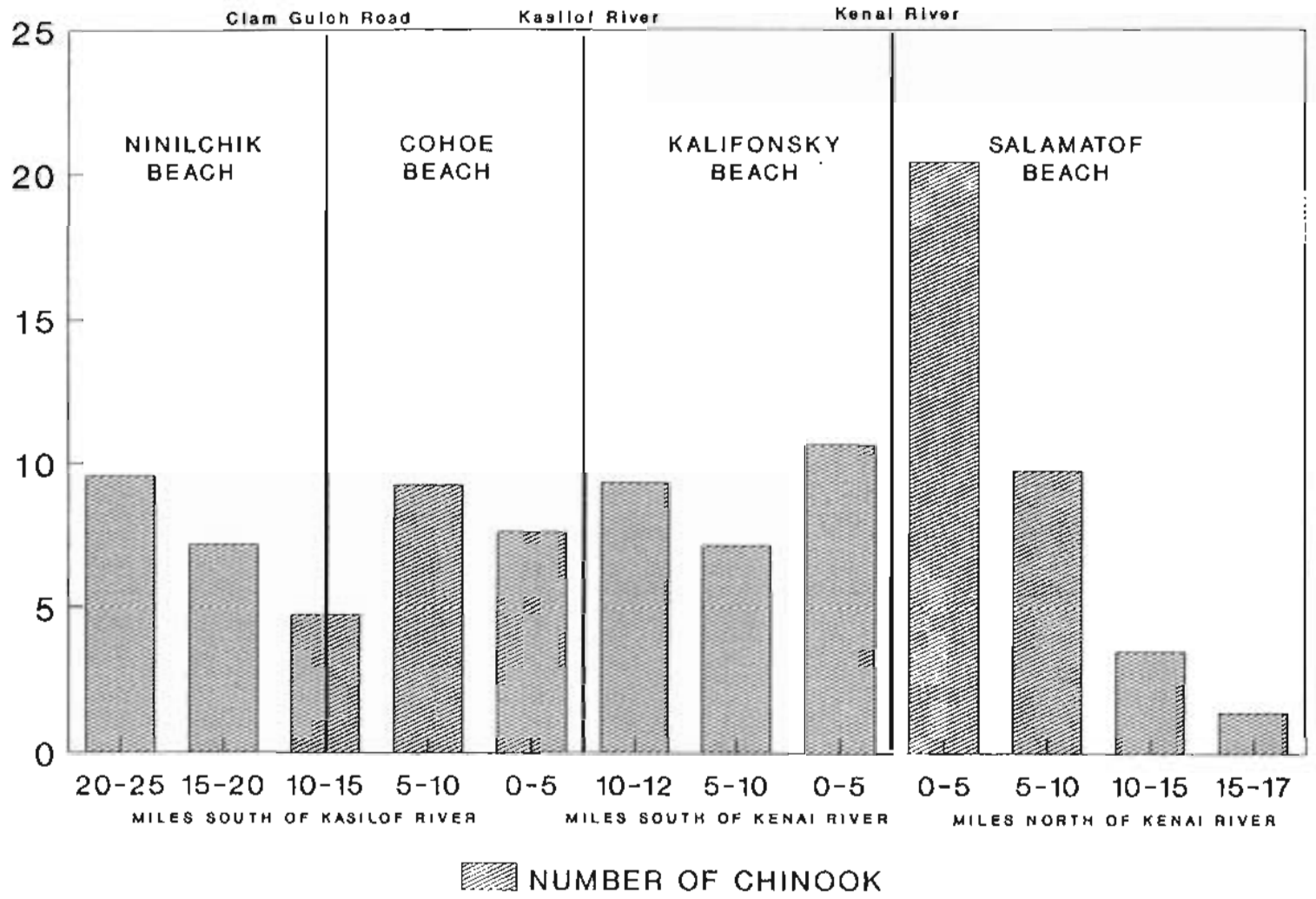

Figure 26. Upper Subdistrict Chinook Salmon Harvest Per Permit by Mile Interval, by Beach, 1990.

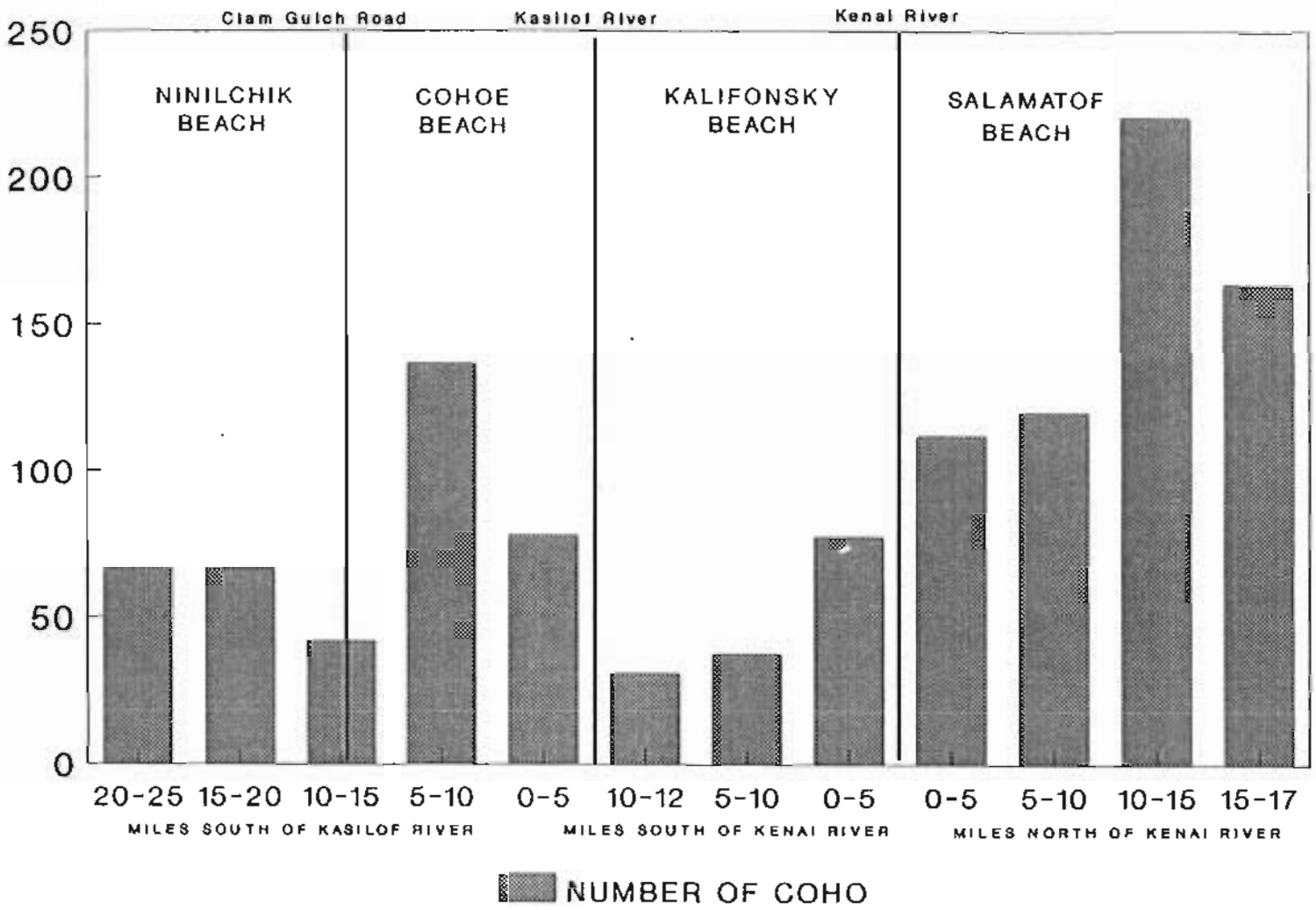

Figure 27. Upper Subdistrict Coho Salmon Harvest Per Permit by Mile Interval, by Beach, 1990.

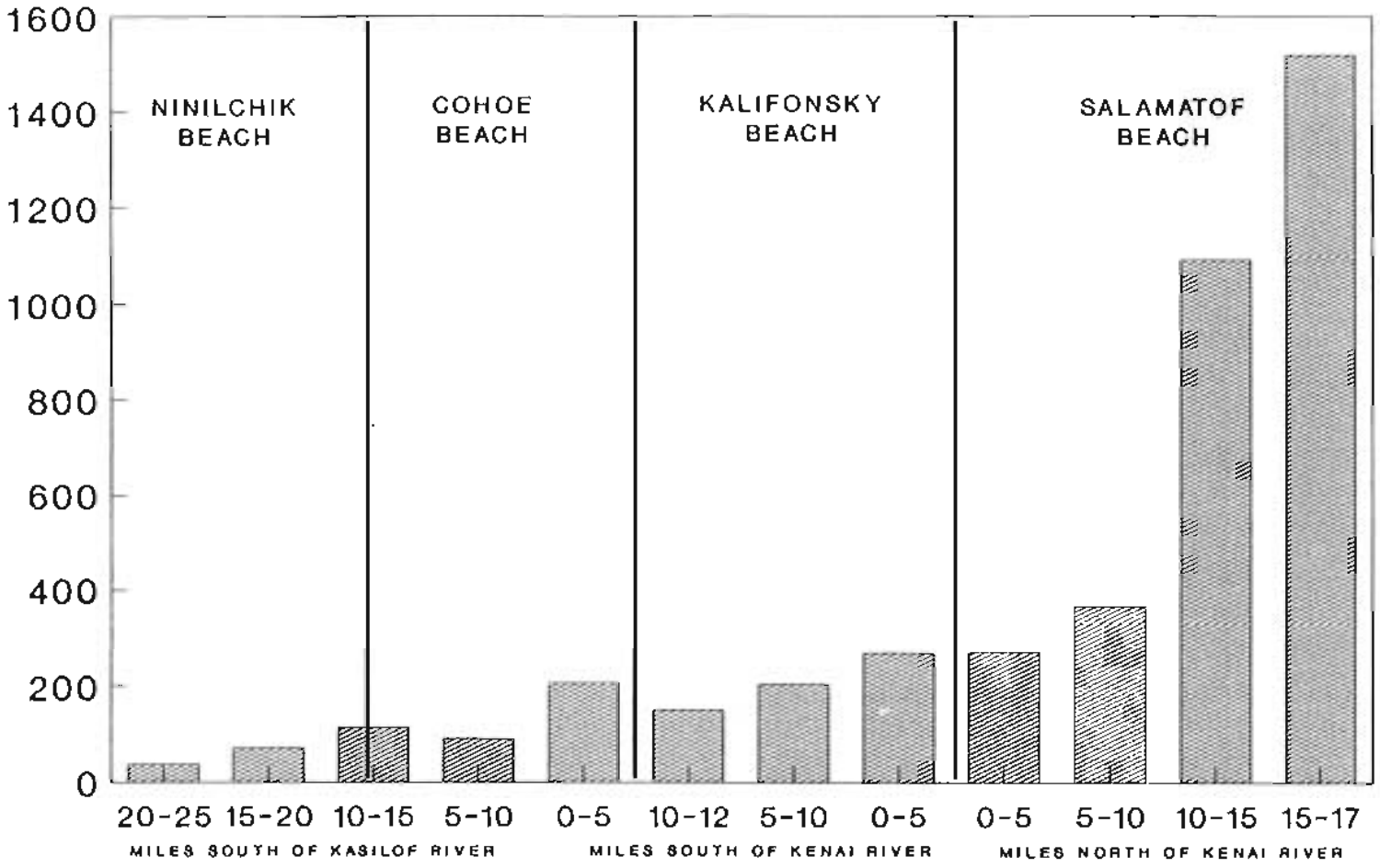

Figure 28. Ratio of Number of Sockeye Salmon Per Chinook Harvested in the Upper Subdistrict, by Beach and Mile Interval, 1990.

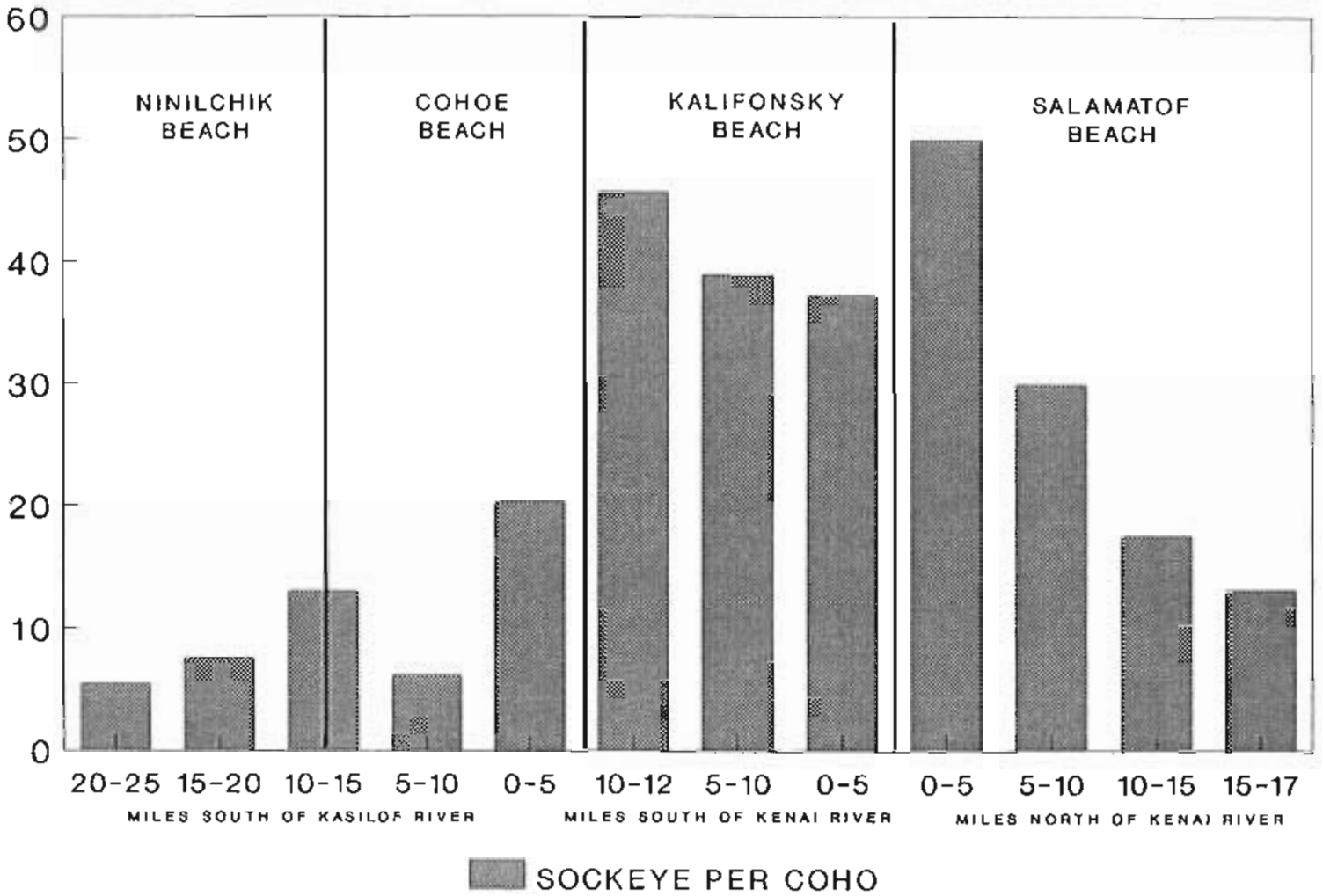

Figure 29. Ratio of Number of Sockeye Salmon Per Coho Salmon Harvested in the Upper Subdistrict, by Beach and Mile Interval, 1990.

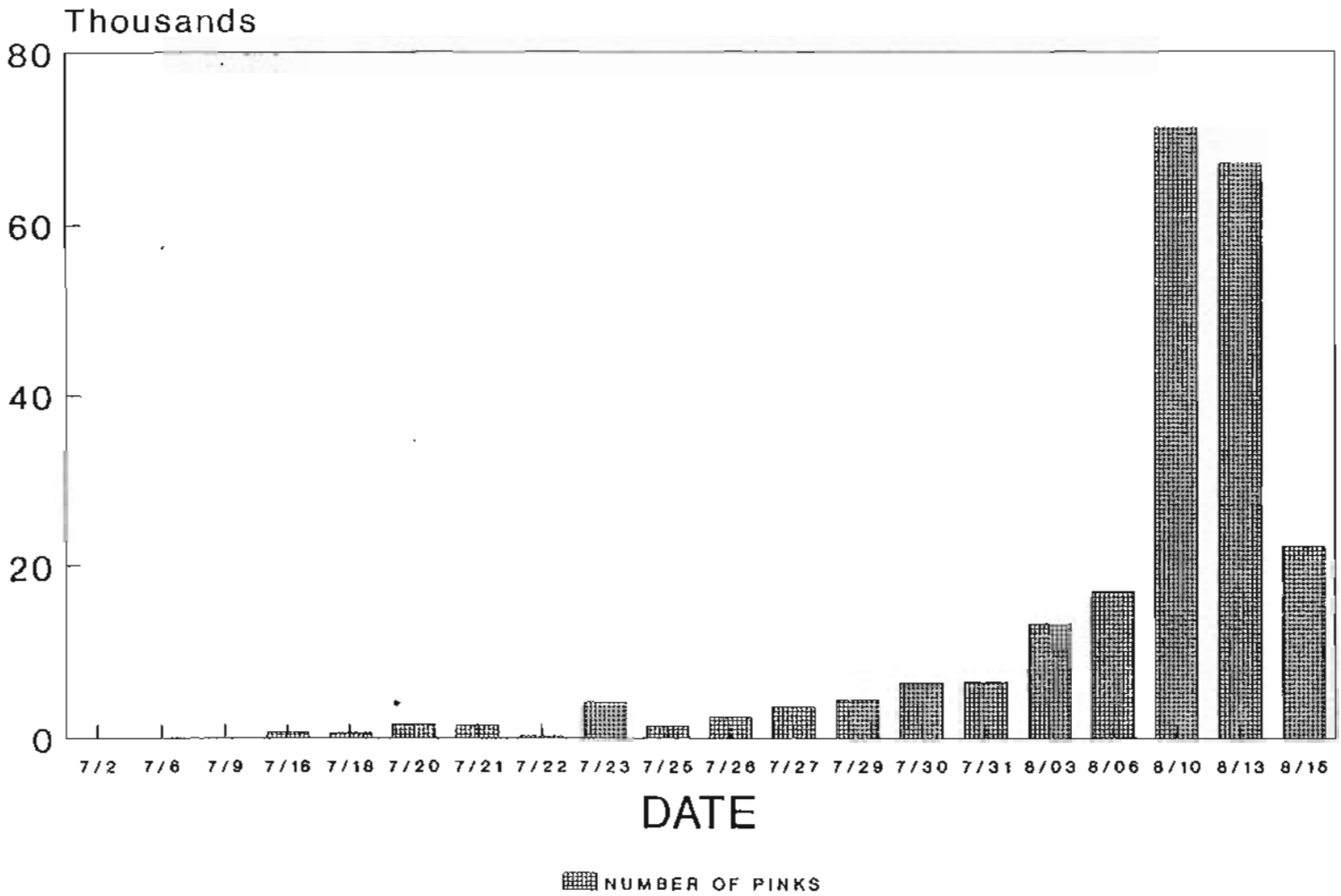

Figure 30. Daily Upper Subdistrict Pink Salmon Harvest by Set Gill Nets, 1990.

SURVEY of UPPER SUBDISTRICT
SET GILL NET FISHERY
UPPER COOK INLET
1990

Principle Contact

Name and permit #: _____

Location of fishing site: _____

Other family or group members fishing together

Names and permit #s: _____

_____

_____

_____

_____

Number of nets fished: 0 - 1/2 mile _____ 1/2 - 1 mile _____ 1 - 1 1/2 mile _____

Does this change thru the season? How? 0 - 1/2 mile _____

_____

_____

1/2 - 1 mile _____

_____

_____

1 - 1 1/2 mile _____

_____

_____

Mesh size of nets: 0 - 1/2 mile _____ 1/2 - 1 mile _____ 1 - 1 1/2 mile _____

Depth of nets (meshes): 0 - 1/2 mile _____ 1/2 - 1 mile _____ 1 - 1 1/2 mile _____

Does this change thru the season? How? 0 - 1/2 mile _____

_____

_____

1/2 - 1 mile _____

_____

_____

1 - 1 1/2 mile _____

_____

_____

Do any of the above move to other statistical areas?

Appendix A.1. Survey form of Upper Subdistrict set gill net fishery, 1990.